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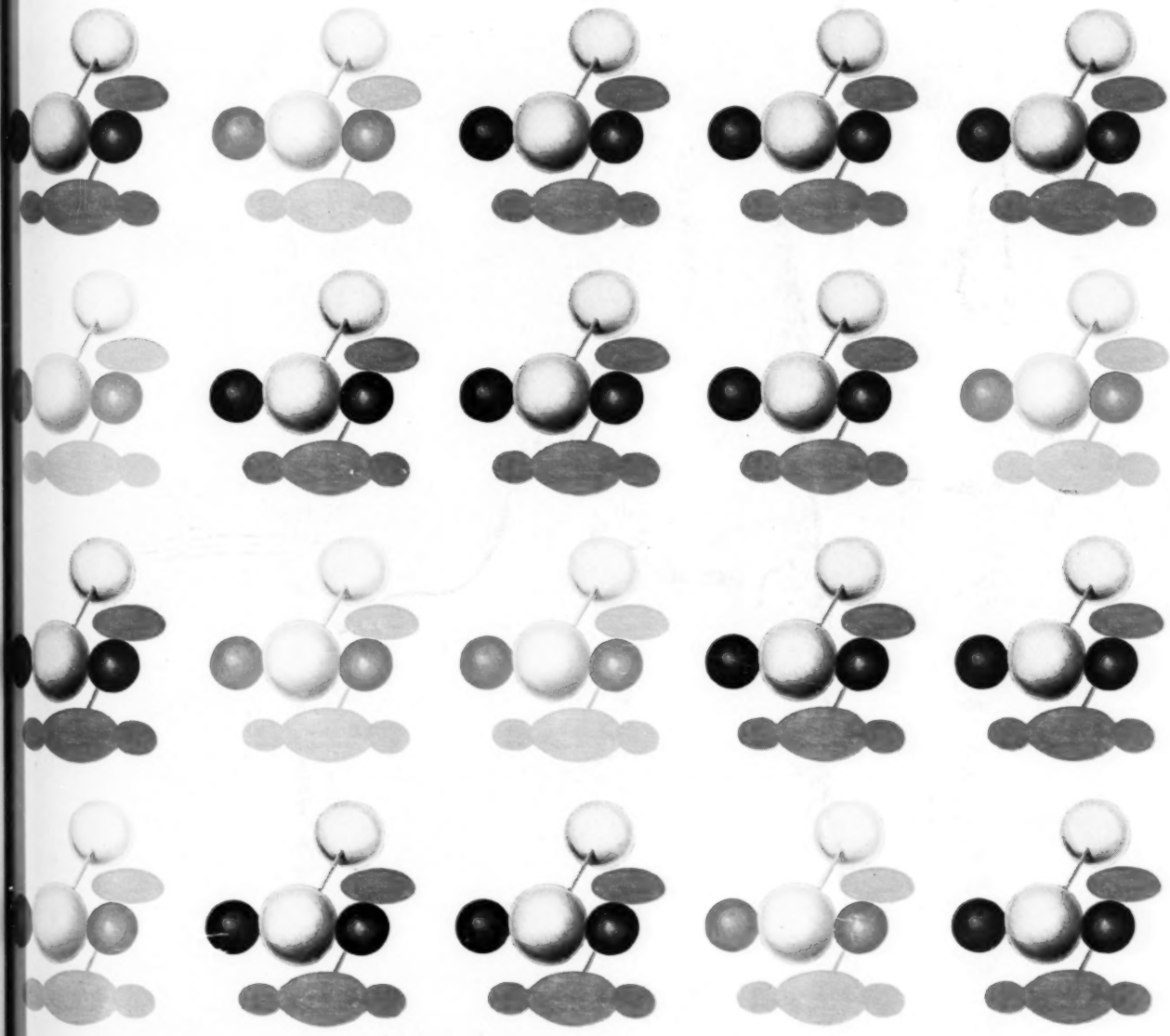

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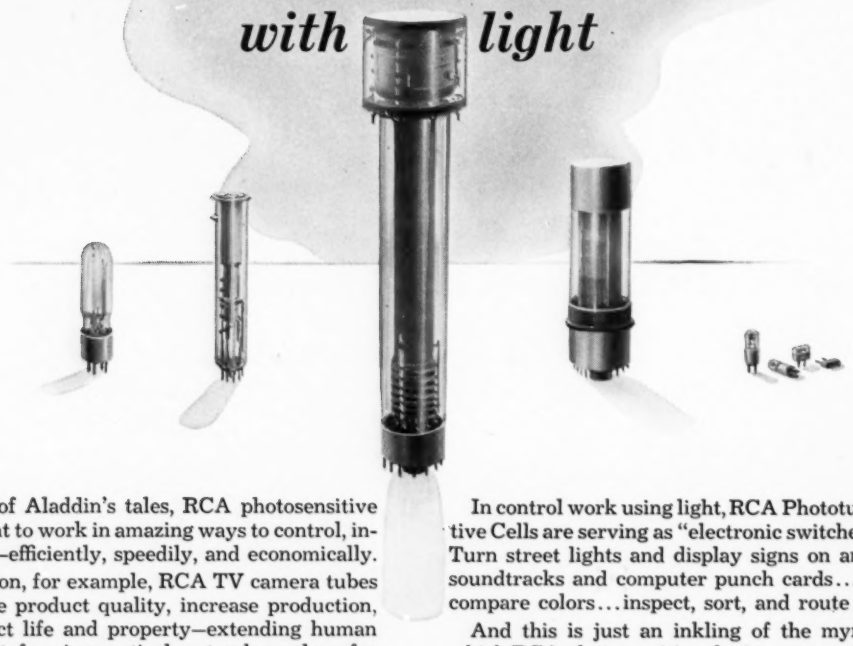

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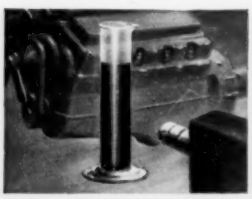

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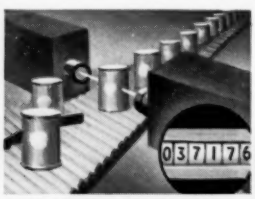

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FOR MORE INFORMATION CIRCLE 1 ON PAGE 48

Research & Engineering

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R/E

JANUARY 1957

VOL. III No. 1

LITHIUM: Now and Next Luckenbach and Verdieck **11**

Lightest of the light metals—once the most abused of the versatile elements—Lithium comes into its own. R/E takes a look at its qualities and exciting growth.

ADMINISTRATIVE ASSISTANTS: How To Use Them Scott Nicholson **14**

Are they cures for real problems or just crutches for the R/D manager who doesn't know how to delegate responsibility? Here we have some prescriptions and prognoses.

FACE TO FACE: R/E Interviews Levenstein of R.I.A. **17**

Motivating engineers and researchers, the Sarnoff plan for loaning engineers to our schools, and an optimistic view of the possible Russian lead in technology are all dealt with by a leading management thinker.

. . . And Now, Plastic Missiles Gerald E. Dodson **20**

When research reaches a plateau, there is a pause, a consolidation of knowledge, then a surging advance in technology. High-temperature plastic laminates are approaching a plateau now.

Engineer-Writers Are Made, Not Born Robert R. Rathbone **22**

Too much of industrial writing is at best unreadable, at worst ungrammatical. Here is a way for management to do something about it.

Did Your Education Educate You? **29**

Here is the consensus of opinion among General Electric's personnel: and some comments on the survey's assumptions by Associate Editor Sandek.

Technical Management: Is Your Library An Asset? **3**

Williamson takes an appraising look at an important—and neglected—research and development assistant.

Editorial: Let's Define Human Engineering **9**

Human engineering needs to be defined by all the many fields affected by this new science.

LETTERS	**4**	**LABORATORY EQUIPMENT**	**42**
YARDSTICKS	**26**	**R/D CONTRACTS**	**44**
MATERIALS	**30**	**BOOKS**	**45**
COMPONENTS	**34**	**REFERENCE TEXTS**	**46**

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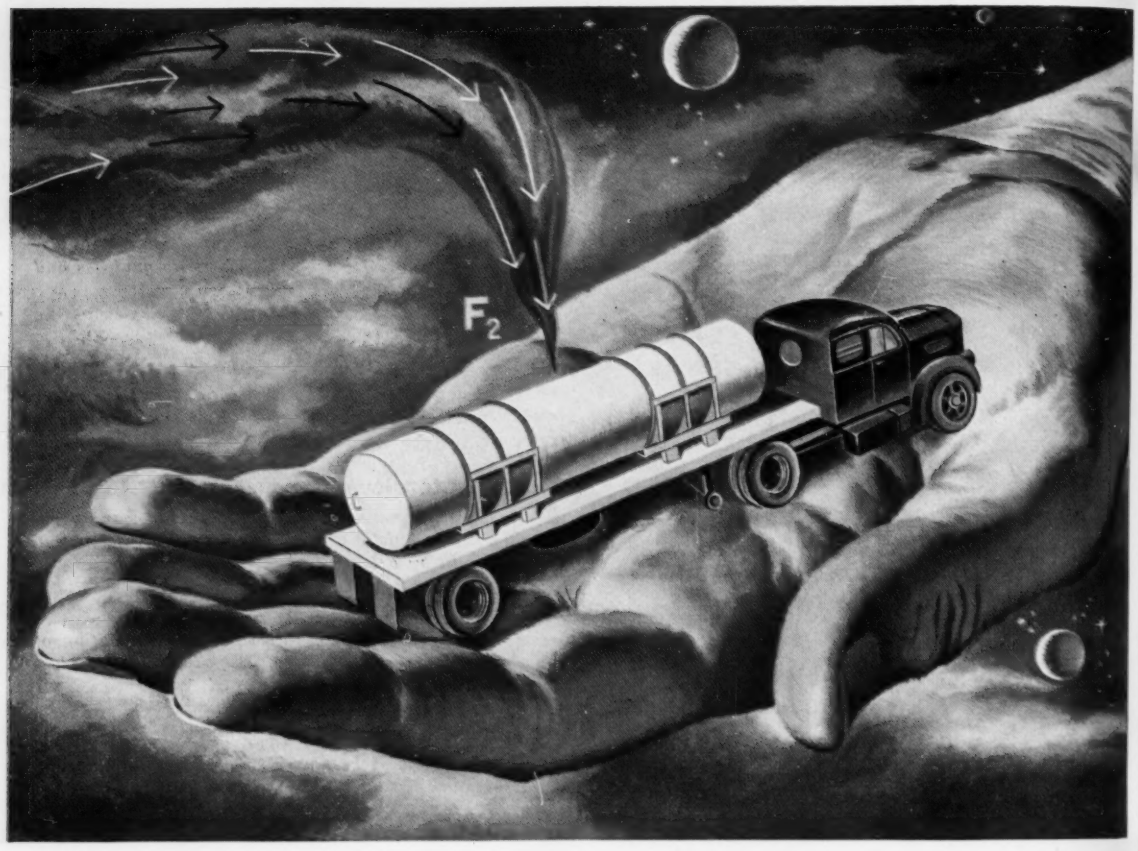

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FOR MORE INFORMATION CIRCLE 2 ON PAGE 48

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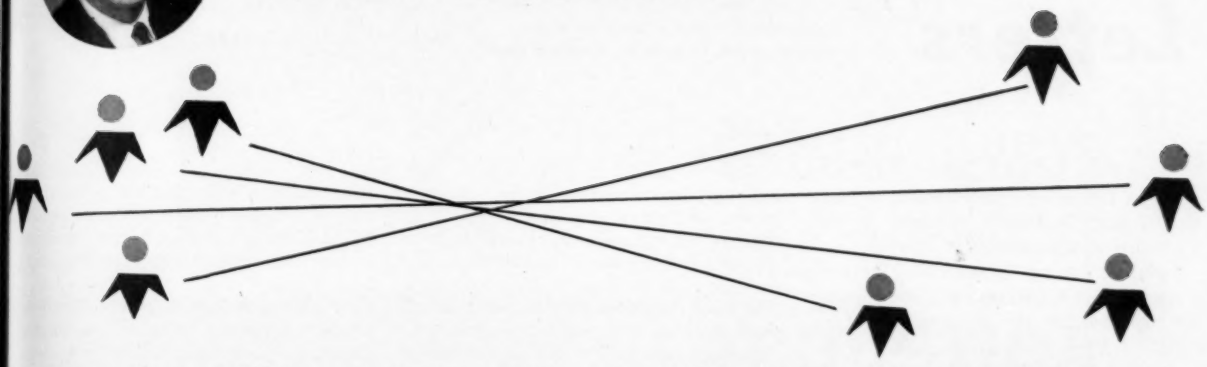
MERRITT A. WILLIAMSON



This month I would like to talk about one of the vital services to Technical Management. This is the library. I must confess at the start that I wear two hats in this discussion since at one point in my life I was a part-time librarian.

As a technical manager you are probably somewhat removed from the strife and bickering that frequently occurs in a company library. Your librarian—probably a conscientious person—tries to iron out her disputes with your engineers without bringing these matters to your attention. But these wrangles often take place. And when they do they consume a great deal of valuable time, energy, and emotion.

What are some of the reasons for these disputes? One reason, undoubtedly, is lack of consideration on the part of your engineers. Men, who in their everyday behavior are responsible and considerate, often become thoughtless and cantankerous in their dealings with the library. They forget to return books, misplace reference texts, "raise the roof" when the item they want is not immediately on hand, and make unreasonable demands in a number of other ways.

The next reason may come as a surprise to you, but it won't surprise your librarian. It is simply this: many engineers have never learned how to use the library. You may be under the impression that of course every engineer knows how to pursue library research. If you honestly think this, ask your librarian if it is so. You will, I am sure, get an eye opener.

Beware the "Archivist"

Even more important may be the fact that your engineering and library staffs disagree as to what a library is for. Some libraries don't circulate books. In fact, they forbid any loaning whatever. Archives are operated that way. Archivists get disturbed about books that are loaned out, and from my conversation with technical managers, I am given to understand that the "archivist" is not unknown in technical libraries.

In my opinion, the ideal philosophy for a librarian to adopt is to encourage maximum loaning of library material. If the books are withdrawn, then chances are improved that they will be used. However, I qualify this with the recognition that books when lost are hard, sometimes impossible, to replace. But a restrictive policy on loaning books shouldn't be used to cover up careless procedure in the library.

I can't understand why library users so blithely ignore library rules, or on the other hand why librarians are so quick to interpret human error as a personal affront. It may be that users are indifferent to the library rules because the enforcement is lax. It may be that the librarian is sensitive to violations because she realizes that she has failed to develop effective follow-thru on control cards and penalties.

Whichever the case, the solution frequently rests with the technical manager. I suggest giving some attention to the following questions the next time you are asked to resolve disagreements between your librarian and your engineers.

Have you a written statement anywhere that spells out what is expected from the library? Such a formalized statement of the rules and fines, backed by the authority of your office, will help the librarian get cooperation without threats or argument.

Do you give your librarian a preview of the research questions that will be coming up? I think every technical manager should insist that the logical first step in the planning of any new project is for the project engineer to have a talk with the librarian. This will pay big dividends. Also, the librarian should be encouraged to attend the initial project meetings to get a "feeling" for the project. I think the absence of the librarian in any planning session is serious and some one ought to be held accountable for her presence. The value of the service obtained from the library will in my opinion, be in proportion to the understanding which the librarian has of the project, and not proportional to the number of specific and often (to the librarian) unrelated demands by different people in different areas.

Is the library physically equipped to do an adequate job for your technical organization? I believe that every technical library should meet a certain standard in the reference aids it keeps on hand. Certainly the bare minimum should include a complete index of past work that has been done in the company as it appears in project reports, technical memoranda, and patent notebooks.

Has sufficient attention been given to improving library rules and procedures? While I realize that most of the fault may lie with the library users, and that their attitudes could stand improvement, nevertheless I think you have to accept the fact that the habits of employees are hard to change, and that you will have to adapt your procedures to minimize this deficiency.

(Continued on page 40)

Letters

Please send all letters to the editor to our editorial offices, 77 South St., Stamford, Conn.

The following two letters take issue with the November editorial in RESEARCH & ENGINEERING. In that editorial ("Taking Human Engineering Away from Us Humans"), we opposed a proposal by Mr. George A. Peters, Jr., of Picatinny Arsenal that a Society of Human Engineers be established. Mr. Peters' rebuttal was published on page 28 of last month's issue. Our reply to all three comments is carried in the editorial on page 9.

A Vote For Human Engineers

Lafayette, Indiana

Your November editorial makes two main points by way of objecting to the proposal that a separate organization of human engineers be established. These points are: 1) such an organization would aid in the "disintegration" of the engineering profession, and 2) such an organization is not needed because the many existing engineering and scientific societies make an interchange of communication easy.

With regard to the first point, I feel that such an organization will act to further *integrate* rather than disintegrate the engineering profession. Whether anyone likes it or not, we are daily traveling further into a world of specialization. The world will never again see people, like DaVinci, who are able to make brilliant contributions to all branches of science.

This team approach requires the integration of knowledge from many diverse fields and brings with it the subordination of allegiance to any of the separate disciplines. An organization of human engineers would aid in integrating the profession of engineering with the other disciplines that contribute to the practice of human engineering and result in the fashioning of an even more powerful technique. Being interdisciplinary in nature, the proposed organization merely reflects the current trend in science and technology which can hardly be said to be "disintegrating".

With regard to the second point, I think that precisely because there are so many scientific societies and publications, an interchange of communication on a routine basis does not now exist. Engineering and professional societies have already cooperated in co-sponsoring special symposia and meetings devoted to human engineering matters. Society and technical magazines have published papers on human engineering. But it is because the symposia and meetings were special meetings and it might have been necessary to *persuade* co-sponsorship, that such ventures do not point to an avenue which will permit the ready exchange of information on a regular basis.

The large number of journals and magazines that have carried (and an increasing number probably will carry them) articles of interest to those working in human engineering makes it impossible, both physically and financially, for one to read them all. With but few exceptions, all of the articles appearing to date have been introductory in nature and directed toward those who are relatively or completely unfamiliar with the field. These are usually "one-shot" deals that are not intended for one working in the area. The magazines carrying them are generally oriented toward a class of equipment and do not operate to disseminate detailed accounts of research results.

Presentation of current research findings is confined primarily to three psychological journals (which are seen by virtually no nonpsychologists) and to reports published by government agencies which do not give wide circulation to these works. Thus, those working in human engineering are quite like the Ancient Mariner who cried "Water, water everywhere and not a drop to drink". With all the societies and publication media now in existence, not one of these can fulfill the unique needs of human engineering.

Human engineering is not a static tool but is a dynamic development which has only recently crystallized into a technique which recognizes the need for a great deal of further development. It is hardly an "everyday tool" as yet although it certainly should be. Until the day dawns that we can look upon human engineering as an everyday tool, it seems unlikely that there will be any danger of its being ". . . canonized into the status of a sacred relic to be caressed only by the recognized faithful".

JOHN D. VANDENBERG
GRADUATE STUDENT, PURDUE UNIVERSITY

Human Engineering— A Bewildered Adolescent

San Diego, Calif.

The argument in your November editorial appears to be based on the assumption that human engineering is little more than a collection of principles—magic formulae which could be applied to recalcitrant man-machine problems and presto systems compatibility would be assured. Unfortunately for industry, no such magic formulae exist. Even the applied workday human engineering problems, particularly those encountered in the defense industry (where most human engineering endeavor is concentrated), involve considerable knowledge of psychology, physiology, anthropometry, and mathematics, to mention but a few of the sciences involved. Certainly these are not fields which a mechanical or aeronautical engineer could just pick up along with the tremendous amount of precise knowledge he already has to absorb.

However, though human engineers—and human engineering societies currently organizing—may protest your stand, they are treading shaky ground if they wax indignant. They have much to answer to. The wide divergence between your views and those of ardent proponents of human engineering as a separate and unique science in many ways represents the bewildering status of human engineering today.

First, human engineering is a relative newcomer to the industrial world. For all practical purposes this hydra-headed science was born during World War II, when the imperative need for psychological and physiological information arose in connection with the operation of new complex and awesome weapons of war. The design engineer just couldn't "pick up" the psychological and physiological knowledge needed. Now, some 15 years later, the science is wearing its first long pants. It's a grown boy but it's not yet a man; and like a growing boy, it has not yet found its direction.

Human engineering has not yet been formalized, let alone properly defined. At present we hear of biotechnology, psychoacoustics, biomechanics, engineering psychology, human factors, and a host of other terms which, boiled down, refer to some aspect of the relationship between man and his machine creations.

A second difficulty in the path of precise definition and formalization of human engineering arises from those who employ it—the manufacturers. Many manufacturers, particularly those engaged in producing the weapons which reach the uttermost tolerance limits of human performance, have recognized the need for human engineering without

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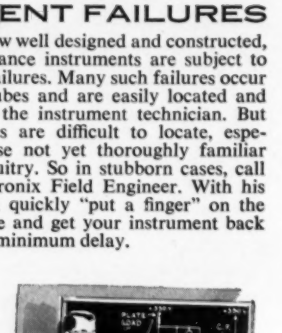

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FOR MORE INFORMATION CIRCLE 4 ON PAGE 48

Letters—Cont.

thorough knowledge of either its content or applications. Consequently, human engineers are apt to be assigned to almost any type of task on the basis that humans must operate the device. There is such involvement in operating a washing machine, too, but most housewives get along very nicely without a human engineer at hand. It's just as senseless to assume that the sole criterion for human engineering is a man-machine operation.

Hodgepodge of Practitioners

Due to its newness and lack of academic formalization, the ranks of human engineers are filled with a hodge-podge of practitioners. They reflect all degrees and all kinds of ability. In addition, there are the "pure theory" proponents who believe that human engineering should exist mainly as a theoretical science. This branch, fortunately small, would let the crumbs of knowledge drift down to the earth-dwelling engineer, where some miraculous application is supposed to occur. This is seldom the case. At the other end of the scale are the "horse sense" enthusiasts who believe that this approach is the only practical one where applied problems are concerned. The "keep-tinkering-with-it" school is of this variety. The best approach would probably lie somewhere between.

A third difficulty concerns the human engineer himself. As a result of his uncertain professional status (at least in the eyes of others), he often allows himself to be cast in a catch-all category. He becomes either a performer of odd jobs, a human do-it yourself kit, or he is involved in pure design work better left to the design engineer. As a result of this lack of professional status, the engineer is uncertain of the relationship which is supposed to exist between himself and the human engineer. Too, the mechanical or aeronautical engineer often feels that the human engineer has usurped his job—is doing work which rightly lies solely in his province. Unfortunately, all too often he is right. But again this may be blamed on the employer who fails to clarify his chains of command and areas of responsibility.

All this has helped cloud the role of the human engineer. What is he? Psychologist? Physiologist? Mathematician? Engineer? The list is long. More important, what does he do? Some design engineers, especially in the aircraft industry, regard the human engineer with high approval. Good working relationships have occurred. Other engineers consider him some kind of modern engineering medicine man with a handy bag of sometimes useful tricks. Still others just shake their heads sadly whenever the profession is mentioned. A few employers who have invested a lot in human engineering activities are hard put to

understand why the "miracles" haven't happened. They, too, are unhappy and uncertain.

These various attitudes probably stem from experience. This, in turn, largely follows from the status (and job) given the human engineer by his employer (as well as the human engineer's professional qualifications for the job he's assigned to do). In general, where definite areas of responsibility have been designated and clearly understood by all concerned, the better relationships probably exist.

Another and very major difficulty lies in the old bugaboo of "communications breakdown". The greatest number of human engineers come from the social and life sciences fields, with psychologists leading the parade. They speak a different language, think differently, approach problems differently, and are inclined to make little attempt to translate their work into results understandable and usable by the engineer. This is not merely a superficial difference but one, which, to date, has seldom been bridged in a manner satisfactory to both professions. In addition, the human engineer is often concerned with such abstract things as learning, transfer-of-learning, memory, conditioning, emotional states, etc., subject matter which is extremely difficult to transfer into usable engineering data.

One professional human engineer recently put the problem this way to the writer: "You don't expect the mechanical engineer to know psychology. Then why should you expect the human engineer to know mechanical engineering? Unfortunately, his fervor doesn't make his argument valid. It is quite true that we shouldn't expect mechanical and aeronautical engineers to be psychologists. But some knowledge of mechanical engineering (the more the better) should be requisite for every person who considers himself a professional human engineer. He can't just randomly suggest changes in a machine system.

Despite recognized and unrecognized problems which threaten to stifle human engineering during its present adolescence, or relegate it to an odd-jobs status, the need for its particular forte becomes ever more imperative. When man began his long journey into the tall blue, he became first an intimate partner and then a part of the machine which bears him upward. This role of the human operator as a link in the complex machine system required that this link, also, be considered in the overall design. It is the human engineer's job to work with the design engineer in fabricating the new systems of protoplasm and steel. But, inevitably, the human engineer's role must remain a specialty. Formal organization is the inevitable consequence.

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HIGH ENERGY

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FOR MORE INFORMATION CIRCLE 6 ON PAGE 48

Let's define human engineering

A CALL TO MEETING

From the response to our November editorial ("Taking Human Engineering Away From Us Humans"), it is apparent that there is a great deal of confusion about the status of human engineering. As you can see by the two letters on the preceeding pages, we don't have a clear picture of:

1) what human engineering is

2) what human engineers do

3) what professional training prepares a man to be one, nor even

4) how many there are

Will the picure scan well if a Society of Human Engineers is set up, as suggested recently by Mr. George A. Peters, Jr? We still don't think so. Human engineering is a technique used by engineers or a supporting service to the engineer's efforts rather than a separate branch of engineering. However useful the proposed society would be as a medium of communication, it would also aggrandize human engineering and try to make it a separate branch of engineering. We suggest the calling of a national meeting at which all the professional societies having an interest in the field are represented. Such a meeting, made up of representatives of all branches of engineering plus the psychologists, mathematicians, physiologists, and medical men, could do the much-needed job of defining this field.

If the meeting sees the need for special courses in this field, even curricula leading to a degree in human engineering, its recommendations would carry far more weight with our universities than those of a small band of professional men mustered under a catch-all flag. One of the first jobs of the convocation could be the selection of a better name than human engineer. A first reaction to this title is that the other engineers are robots or that humans, like machines, are engineered.

Cooperative Journal

If there is a great need for some periodical devoted to publishing the highly specialized articles in this field, we suggest that the professional societies represented at the proposed convocation sponsor a joint publication.* Such a publication backed by the resources and experience of many societies would gain more recognition and have a far greater chance of survival than one put out by a newly formed Society of Human Engineers. The joint publication could be similar to the specialized transactions published by the Institute of Radio Engineers for each of its professional groups or subdivisions.

The Core of the Argument

Whether human engineering is a separate branch of engineering and therefore another specialty is the core of the argument between ourselves and Mr. Peters and the two letter-writers. Mr. Peters and the first correspondent, Mr. Vandenberg of Indiana University, welcome increased specialization; Convair's Mr. Sutton accepts it; and we fear certain dangers in it.

Recently a German missile expert now employed by one of the big American missile makers told us that among the thousands of engineers he worked with, there are many brilliant specialists, but few men who understand the entire weapon system. The result is an inordinately long time in producing an actual weapon. We need men who can understand the entire system, who can lead the teams that research and develop the ever-more-complicated artifacts of our civilization. The alternative is missiles that are obsolete before they are launched and jet planes that haven't the energy to get off the ground.

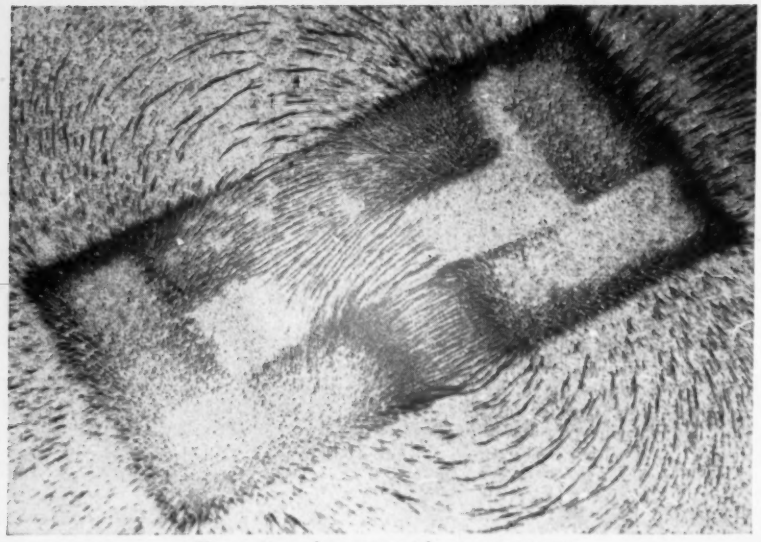
Such leaders and technical managers can't be nurtured by sticking to one specialty. They must range over many specialties and be knowledgeable in two or three, perhaps including human engineering. Our engineering and science schools must try to produce these leaders. The other 95 percent of our technical people will gain by training in a system with the goal of producing leaders.

(By coincidence, just as we finished writing this editorial, we received an article manuscript from Mr. Peters suggesting various definitions for the varied technical types now practicing in the field of human engineering. The article will be published in an early issue of RESEARCH & ENGINEERING.)

Melvin Mandell

EDITOR

*According to Prof. W. H. M. Morris of Purdue University, there are already three journals in the field of human engineering published overseas. They are "Internationale Zeitschrift fur angewandte Physiologie einschliesslich Arbeitsphysiologie"; "Travail Humaine", published in Paris; and "The Journal of the Ergonomics Research Society", starting publication in England with an international board of editors.



Flux pattern of experimental magnetic circuits

How location of magnets affects magnetic circuits

Adapted from an article by Charles A. Maynard, vice president, Research and Engineering, The Indiana Steel Products Company

The LOCATION of permanent magnets in a magnetic circuit is a definite factor in design. To determine the extent to which this is true, involved calculations are necessary.

A comparatively simple experiment, however, which shows the nature of the changes that take place when permanent magnets are placed in different positions in a magnetic circuit, was devised by Mr. Maynard. The material on which the following questions and answers are based was taken from a report, "An Experiment in Magnet Location," published in Vol. 3, No. 5, of Applied Magnetics. *A copy of this issue is available on request to The Indiana Steel Products Co., Dept. Q-1, Valparaiso, Ind.*

Question: What affect does the location of permanent magnets have on a magnetic circuit?

Answer: It has a marked influence on the flux density in the various portions of the magnetic circuit.

Question: Is there a preferred location for magnets?

Answer: Yes, it is important to place the magnets as close to the air gap as possible.

Question: What is the benefit of their location?

Answer: The leakage flux is reduced, and the useful flux in the air gap is increased.

Question: How is this an important factor in design?

Answer: It minimizes the amount of magnet material required to produce a given flux in the air gap.

Question: Does this mean lower magnet costs?

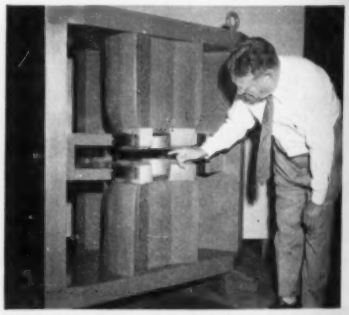
Answer: Generally, this is true. However, structural considerations may prevent the placement of permanent magnets at preferred positions.

Question: Are there available quantitative data which indicate the degree to which magnet position influences the efficiency of a circuit?

Answer: A brief experiment was conducted on the nature and magnitude of the changes that occur when magnets are placed in various positions in a simple magnetic circuit. The results are discussed in *Applied Magnetics*, Vol. 3, No. 5.

World's largest permanent magnet separates electron particles

The largest and most powerful permanent magnet ever designed is an important part of a new Mass Spectrometer to be used for high molecular weight hydrocarbon analysis at the Whiting, Indiana, research and development laboratories of a large Midwestern oil company. Function of the spectrometer is to establish a strong magnetic field that separates electron particles.



Indiana's C. A. Maynard inspects air gap of giant Alnico V magnet assembly

The Alnico V permanent magnet used in the assembly has a maximum field strength of 6,000 gauss . . . equal to 10 tons of magnetic holding force . . . and weighs 1,300 pounds. The complete assembly, which weighs approximately 4,700 pounds, was designed and fabricated by The Indiana Steel Products Company, Valparaiso, Indiana.

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

THE WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

In Canada . . . The Indiana Steel Products Company of Canada, Limited, Kitchener, Ontario

FOR MORE INFORMATION CIRCLE 7 ON PAGE 48

LITHIUM:

NOW AND NEXT

Atomic Number	3.
Atomic Weight	6.94
Melting Point C.	180.
Boiling Point C.	1336.
Relative Hardness	0.60
Density (800°C)	0.46
Melting Pt. (°C)	179.
Volume Change on Fusion (% of Solid Vol)	1.5
Latent Heat of Vaporization (Cal/gm)	4680.
Heat Capacity (Cal/gm°C)	1.0
Thermal Conductivity (Cal/sec-cm°C)	0.09
Latent Heat of Fusion (Cal/gm)	158.
Viscosity (Centipoises)	0.41
Temp. for 10mm Hg. Vapor Pressure (°C)	890.
Electrical Resistivity (m-ohms) (230°C)	45.3

Lithium was discovered in 1817 and languished for a hundred years.

At the turn of the century it was used in the treatment of gravel and as a cure for rheumatic afflictions.

In 1914, the Archives of Internal Medicine reported lithium used in treatment of the gout.

In 1940, Camm's Dictionary of Metals and Their Alloys reported that lithium metal "is without use at the present day. Some alloys of the metal have been made, but these are also useless".

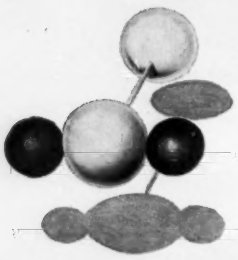
And in 1941 the U.S. Patent Office rejected all claims for lithium grease, arguing that the claims lacked novelty over prior art; and saying in effect that lithium is essentially the same as sodium and potassium. A million dollars later they reversed themselves and granted the patent.

Thus the history and uses of lithium reach through a hundred and fifty years, from medicine for the gout and gravel to inclusion in the hydrogen bomb; and between the extremes, applications and compounds are proliferating.

On the following pages is a digest of the nature, the uses, and the possibilities, for lithium—the lightest of all the light metals.

W. F. Luckenbach, Jr. and R. G. Verdieck

LITHIUM:NOW



Metallurgy:

Lithium metal, in concentration as low as 50 parts per million, removes hydrogen, oxygen, and nitrogen from copper. By acting as a scavenger of unwanted gases, lithium purifies and greatly increases its electrical conductivity.

Because of their ability to flux other materials, *lithium fluoride and chloride* are used in both welding and brazing operations. In combination with other salts, they form compounds with low melting points, high boiling points, favorable surface tension characteristics, and excellent fluxing and deoxidizing properties. They have special utility in aluminum, magnesium, titanium.

Ceramics:

Lithium compounds in modern ceramics function primarily as a flux. When these compounds are added to ceramic formulae, firing temperatures can be reduced and production schedules speeded. Substituted for the salts of the other alkali metals, lithium compounds improve ceramic quality by lowering thermal expansion, increasing chemical durability, raising the refractive index. *Lithium oxide* acts as a catalyst or mineralizer to enhance crystal structure in the manufacture of certain pigments and refractories.

Lithium-containing glass has made possible improved television tubes, cost and weight are down from their lead-containing predecessors. Lithium contributes to thinner, tougher, and chemically more durable, porcelain enamels for appliances and sanitary ware.

Air Conditioning and Refrigeration:

Cheaper and more effective than organic compounds when used as de-humidifiers in air conditioning systems, lithium chloride solutions can function well in concentrations as weak as 35% and at temperatures down to 70°C. They can maintain a constant relative humidity; heat, cool, or wash, the conditioned air. 120°C of heat dries them readily with no decomposition of the *lithium chloride.*

W. F. Luckenbach, Jr. is Manager of Chemical Sales, and Dr. Ralph G. Verdieck is Manager of the Chemical Division of the Research & Development Dep't—both of the Foote Mineral Company, Philadelphia, Pa.

In air conditioning systems, *lithium bromide* in a water solution is an effective and economical refrigerant-absorbent.

The lithium bromide solution working in a vacuum acts like a pump and absorbs steam evolved during the cooling stage. The brine is regenerated for reentry into the cycle by heating it with low pressure waste steam. Lithium bromide systems are completely sealed, require little maintenance, have high life expectancy.

Lubrication:

When a small amount of lithium soap is added to a lubricating oil, the oil acquires the versatility of a whole range of special purpose lubricants: lubricates moving metal parts at ordinary temperatures, protects wearing surfaces at from 60° to 400°F. It is resistant alike to water and abrasion.

Storage Batteries:

The addition of *lithium hydroxides* to the electrolyte of the standard Edison Iron-Nickel alkaline storage battery increases the cell's life and capacity.

Lithium's atomic weight has led to several specialized applications: anhydrous lithium hydroxide has been used as a carbon dioxide absorbent, providing maximum absorption with minimum absorbent weight. Its rapid absorbing action and the non-caking properties of the insoluble carbonate this absorption produces make it an extremely effective material for air purification in the severely limited interiors of submarines. Eight pounds of *lithium hydride* will generate almost 400 cubic feet of available hydrogen, or about the same volume of the gas that can be compressed in two standard metal cylinders. Lithium fluoride is insoluble in water, has unusual optical characteristics. In a highly purified form is used as a single crystal optical unit, and as a reflection-reducing coating on glass optics.

The high electrical conductivity and low freezing points of *lithium chloride and bromide* have made possible dry-cell-type batteries which will function down to 40°C where normal dry cells are inoperative. In this case, the *lithium halide* is included in the paste-type electrolyte.

In a 35-45 percent solution in water, lithium chloride provides a practical and economical liquid that can be used to de-ice aircraft in the Arctic, Antarctic, and other areas where the temperature frequently plummets to 40 and 50 degrees below zero (F.)

The low melting eutlctle mixtures of lithium salts have made possible their use in salt baths of the type employed in metal treating and heat transfer. For example, mixtures of *lithium nitrate,* with the nitrates of potassium, sodium or calcium, yield baths with melting points as low as 119°C.

LITHIUM: NEXT

Nuclear Energy:

The role of lithium as ashless fuel material in future nuclear energy development was pointed out at the United Nations Atoms for Peace Conference in Geneva. A proposed lithium fusion reactor would be cheap in terms of energy yield and would give no radioactive fission products. More recently, the use of lithium metal in a thermonuclear reactor has been suggested. The lithium in liquid form would absorb the tremendous heat generated in the fusion process and carry it to a heat exchanger. Steam thus produced would drive the turbines.

Electrochemistry:

The small highly hydrated, and mobile qualities of the lithium ion and its complex-forming affinity with other ions, make it an ideal agent for electrochemical processes. When *lithium cyanide* replaces sodium or potassium cyanide in bright copper electro-plating, the copper is deposited twice as fast without loss of smoothness or brilliance. This speed-up in copper plating presages possible further applications in electrochemistry—perhaps in the electro-winning of copper, zinc, nickel, and other metals.

The transition from aqueous electrolytic processes to fused bath operations is a logical one for the *lithium ion*. *Lithium chloride* or *fluoride* greatly increases the electrical conductivity and lowers the melting temperature of the bath.

The addition of small quantities of *lithium salts* in the Hall Process for the production of aluminum promises an increase in the deposition rate by allowing higher current densities in the cells. The increasing demand for aluminum emphasizes the importance of an accelerated Hall Process.

Catalysis:

In the polymerization of monomers like isoprene, butadiene, ethylene, and styrene, control of specific isomer formulation determines the properties and quality of the finished polymer. Formerly, careful selection of pressure, temperature, time, mixing conditions and choice of catalyst has yielded only limited control of isomerization. But recently, while investigating the polymerization of butadiene, research chemists catalyzed the process with the alkali metals. Of those used lithium catalyst invariably produced a predominance of 3-4 isomer, as opposed to the random yield of sodium potassium, ribidium, cesium etc. There are probably many catalytic processes in which control of the end product remains erratic or uncertain. Some of these processes might mature into industries of great commercial importance, if a catalyst could be found to insure consistent and uniform production of the end product. Lithium, in one of its many combined forms, might well afford the desired catalytic control.

Lithium's value as a catalytic control in polymerization appears once again when it is used as a synthesizing agent in organic preparations. Combinations of organic molecules can be coupled with high control. *Lithium hydride* and *lithium aluminum hydride* act as specific reducing agents to produce selective organic reductions not possible with either sodium or potassium. The manufacture of Vitamin "A" and certain antihistamines, for example, could not have been accomplished without lithium. Lithium compounds have a bright future in pharmaceuticals.

Heat Exchangers:

Primary among the considerations for any heat exchange system is the specific heat of the coolant. Among the alkali metals, lithium has a heat capacity which is almost 3 times as great as sodium metal—its nearest competitor. Moreover, with a liquid range of 1150°C vs about 800°C for sodium and about 700°C for potassium, lithium far outstrips its congeners in usefulness. Its high boiling point (1336°C) permits its use far beyond the temperatures at which most coolants volatilize.

A comparison of the properties of the alkali metals reveals that lithium is not only a highly efficient heat transfer medium on a per pound basis—but also on a volume basis. Even though its density is about half that of sodium, it is still four times as efficient per unit volume of coolant. The implications for heat exchanger design are obvious.

Pigments:

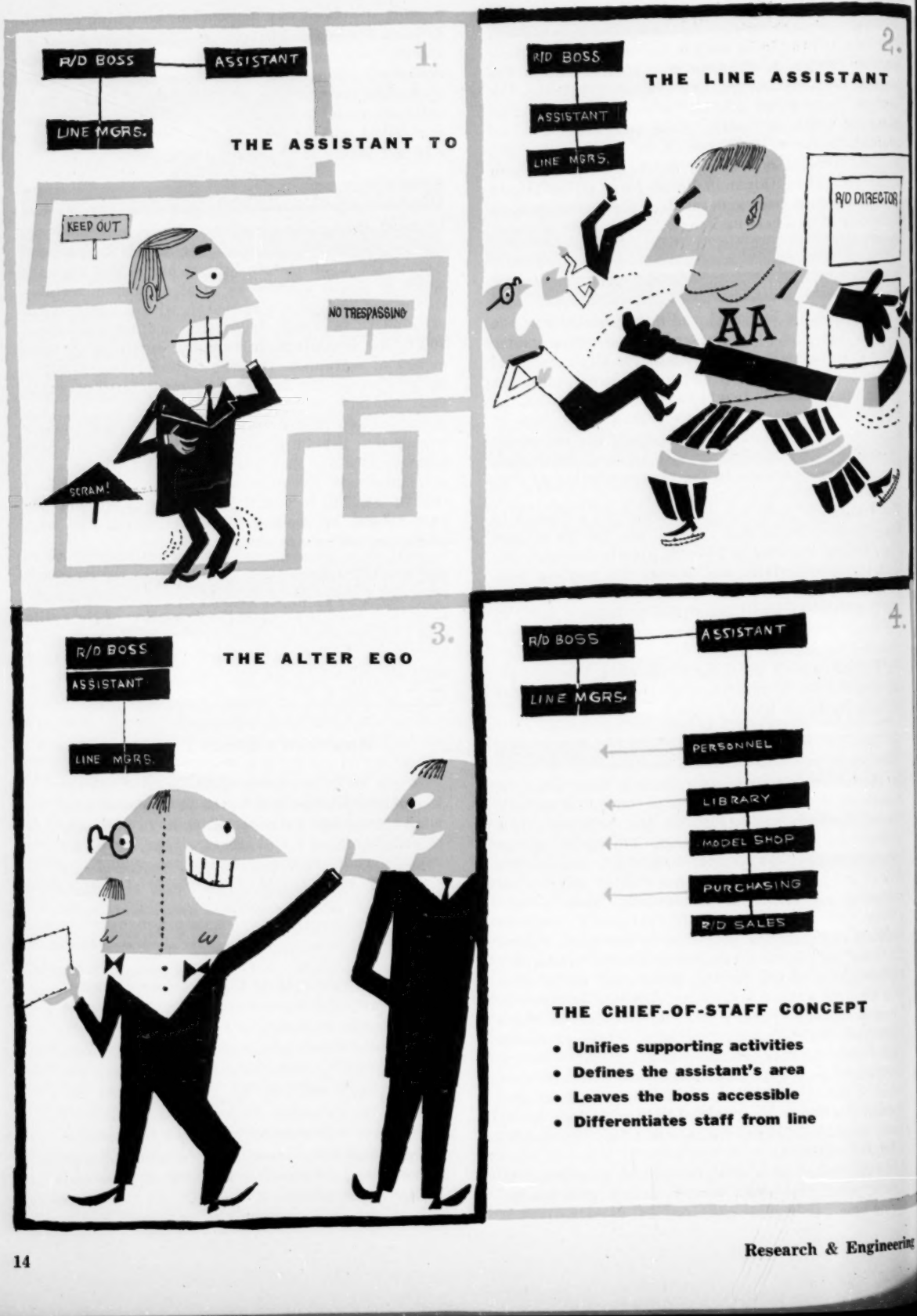
Lithium is used to promote the formation of the rutile type of pigment grade titanium dioxide. More effective forms of other pigments might well result if they were crystallized in the presence of a lithium salt.

American Lithium Institute

Three major producers of lithium and lithium compounds have announced the formation of the American Lithium Institute to meet the growing need for a central agency to direct research on problems of an industry-wide nature. The Institute, with offices in Princeton, N.J., will correlate and disseminate technical information, maintain a reference library and literature service.

The Institute expects to support an extensive program of research and development on problems involving lithium in chemistry, ceramics, metallurgy, and nucleonics. Projects will be assigned to colleges and research institutions, but will be guided by the Institute's Technical Policy Committee, composed of representatives of the three member companies: American Potash and Chemical Corp., Lithium Corporation of America, and Foote Mineral Company.

administrative assistants: *how to use them*



SCOTT NICHOLSON associate editor

If you are a research and development manager carrying a heavy administrative load you've probably wondered how to rid yourself of some of this burden.

Perhaps, like many R/D managers, you once fancied that you could handle the entire job alone, but found yourself mired in administrative detail, neglecting the overall job of organizing and managing.

Or you may have tried a different tack, enlisting the help of the company's headquarters staff. Many large research and development departments do this quite successfully. At General Electric, for example, the personnel staff performs many of the routine recruiting, screening, and personnel chores for R/D groups. At Union Carbide and Carbon, the comptroller's staff has taken over some of R/D's budgeting and recordkeeping. But although this type of cooperation works well enough when the headquarters staff is especially capable, R/D managers have found that letting the work out of the department usually creates more difficulties than it solves. For one reason, headquarters staff reports to a different officer in the company hierarchy. This division of command often results in pulling and hauling in opposite directions. Also, the headquarters group is frequently far removed from the R/D lab or design department, and communication difficulties arise.

This leaves the technical manager with but one choice: to find help within his own department. And in most cases he gets the help he needs by making one of his staff with administrative potential his assistant.

The Dissenters

Organization specialists, however, frown on the use of administrative assistants. They claim that relying on assistants simply conceals the manager's inability to delegate. Many managers use their assistants as crutches when they should be entrusting more of their responsibilities to subordinate managers. A leading New York management consultant explains, "The administrative assistant position is much like the miscellaneous folder in your file or the word *etcetera* in your reports. All three are catch-alls that show an unwillingness to analyze the leftovers and figure out where they properly belong". The best procedure for the overburdened managers, say these consultants, is to train oneself to delegate more responsibilities to the line.

While many R/D directors agree with this idea in theory, they find that it doesn't work too well in practice, at least not in the research department, because of the need for maintaining a creative climate. Since most worthwhile insights require the scientists to become deeply engrossed in the problem, it is wasteful and expensive to interrupt his concentration with an array of administrative chores which someone else could handle.

Actually, most technical managers say, there's nothing inherently wrong with the use of assistants. It's only through misuse that trouble arises.

A number of technical managers have made a striking success out of their collaboration with administrative assistants. Research directors in several companies, including Bell Labs, Sylvania Electric Products, Goodrich and Stauffer Chemical have come to believe that many of the drawbacks in the use of administrative assistants can be avoided. An analysis of the methods employed by top men in these labs show that nothing very complicated is involved in this business of managing through administrative assistants—a few principles perhaps, but nothing that the average technical manager can't master.

1. Don't Low-Rate Your Assistant

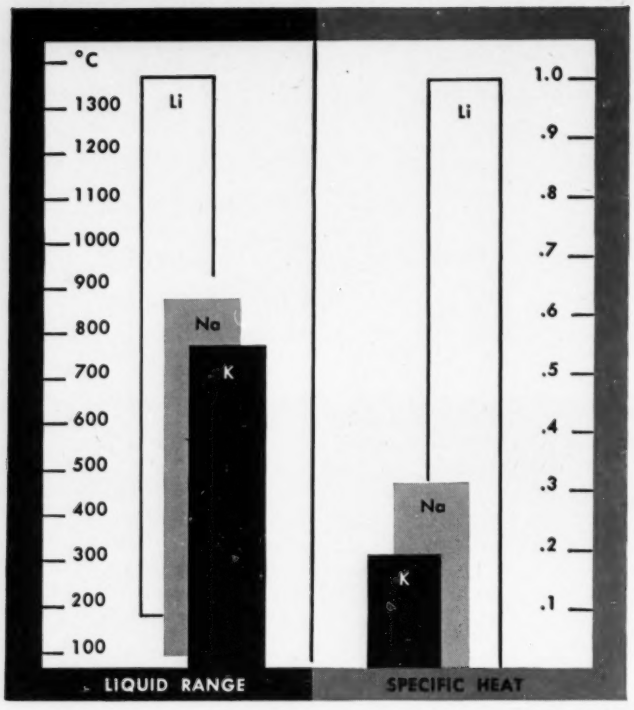
It would seem logical, after paying the salary which an administrator-engineer combination commands, to give the assistant duties equal to his ability and pay scale. Yet this does not always happen. The amount of authority and responsibility that assistants receive varies from company to company. In some labs the administrative assistant has duties commensurate with his abilities and pay scale. But in others he does jobs which a clerk or messenger could easily perform, such as picking up theatre tickets and plane reservations, performing elementary filing and sorting assignments, and making rush deliveries. Such uses not only humiliate the capable engineering administrator, but also negate the most important contribution he could make—that of relieving the boss of the really difficult administrative problems.

Used properly, the assistant should assume such tasks as co-ordinating projects, checking work in progress, listening to complaints, editing reports, riding herd on deadlines, maintaining personnel records, and developing procedures. Such uses in turn free the boss to devote his full attention to the overall problem of planning, organizing, and controlling his department, where his prestige and ability count most.

2. Avoid The Line-Assistant Blockade

Giving your assistant duties beneath his abilities invites frustration. But, going to the other extreme in an effort to build him up can sometimes be just as bad. Some technical managers give their assistants too much authority and responsibility instead of too little. When this happens, the assistant's true role should be pictured as that of a *line* assistant (see figure 2). That is, he is the only person reporting directly to the boss. The subor-

(Continued on page 36)



paradoxical

"Lithium Metal? Just another alkali!" is the way people used to describe this lightweight in the first group of the Periodic Table. But recently this dynamic element has begun to rebel. Hardly a typical alkali, its very difference may be considered its greatest strength. In just the past few years, lithium metal has emerged—

As a Catalyst—Lithium Metal now provides excellent control in polymerization and chemical reductions at extremely low cost.

As a Heat Transfer Medium—Lithium Metal is potentially the most effective and efficient medium for any high temperature exchange system. Its heat capacity is three times that of sodium, its nearest competitor.

As a Metallic Scavenger—Lithium Metal reacts with a great number of gases to form stable compounds, absorbing large volumes of gas. Hence its use as a deoxidizer, desulfurizer, and degassifier—while also increasing conductivity of castings through better homogeneity.

As a Hi-Temperature Fuel—Lithium Metal and its derivatives show great promise in the production of new rocket fuels.

As a Thermonuclear Material—Lithium Metal provides two isotopes with almost opposite characteristics. The high nuclear cross-section of lithium-six suggests use as a thermonuclear fuel. The low cross-section of lithium-seven presents interesting possibilities along allied lines.

The same properties which have taken Lithium Metal out of the doldrums and launched it into an exciting future may very well apply to your work. In fact, we venture to say that within the next five years you will be using lithium metal—in research, in production, or in your product directly—or have to know the reason why you are not. Foote Mineral Company, as a producer of 99.8%-pure lithium metal, stands ready to help you get there faster—maybe first. Our Technical Data Bulletin "LITHIUM METAL" is a good start. Your copy is awaiting your request—at 455 Eighteen West Chelten Building, Philadelphia 44, Pa.

Foote
MINERAL COMPANY

RESEARCH LABORATORIES: Berwyn, Pa.

PLANTS: Cold River, N.H.; Exton, Pa.; Kings Mountain, N.C.; Knoxville, Tenn.; Sunbright, Va.

FOR MORE INFORMATION CIRCLE 8 ON PAGE 48

FACE TO FACE

R/E INTERVIEWS LEVENSTEIN OF R.I.A. ON

MOTIVATION VS. MANIPULATION

Aaron Levenstein, Directing Editor, Associate Membership Division, Research Institute of America, N.Y.C.

Mr. Levenstein was interviewed by Melvin Mandell, Editor of RESEARCH & ENGINEERING. The Editor's questions are in the dark type. Mr. Levenstein will discuss "Motivation Versus Manipulation" in March at the National Convention of The Institute of Radio Engineers. He will address the Professional Group on Engineering Management.

Your special field is human relations in industry, isn't that so?

Yes, I think it is important to start out with the awareness that human relations is a recent development in employee management. Older motivations—fear, pressure, the danger of being rendered unemployable — have proved inadequate under existing conditions. I can single out two specific developments that have destroyed the effectiveness of the old motivations: union organization and full employment. A man can lose one job, then just walk down the street and get another. That's particularly true in the field of engineering.

Wouldn't you say in general that of those two factors, the engineer is not so much affected by unionization as that fact that he can get a job easily?

But the result is the same. Right now, because we lack the old device of motivating men by fear to work, we began to look for new ways of influencing their behavior on the job.

What is your definition of human relations?

It is that combination of art and science that makes it possible to determine what a man's needs are on the job, and to proceed to meet those needs in terms that provide for him incentives to work, incentives that go beyond money. I think with that as a starting point we can then profitably examine what is being done in industry now. You will find that the application of human relations has taken either of two directions. It has become a device that business has used to manipulate people into acting in conformity with the wishes of management. I think that the record of paternalism in American industry demonstrates that that's not the answer. In the long run where manipulative devices are used, the individual comes to recognize that he's being manipulated.

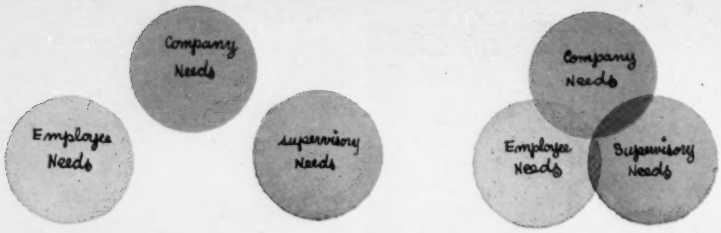
What's the difference between manipulation and motivation?

Motivation directs itself towards determining the individual's needs with a view to satisfying them within a framework that makes it possible to achieve mutual interests. In that particular study that I've given you there, we develop a two-part thesis. One is a rejection of a view that was held for quite a while in human-relation circles that if you could build a man's morale, you will be pretty sure to get higher production out of him. Well, the truth is that good morale does not necessarily mean better or higher production from a man. A man can be very happy on his job —his morale is good, he comes in every morning with a feeling of real comfort about the environment he's going to find himself in, but with no real incentive to work. It takes more than good morale to get a man to perform on the job. First of all, he's got to recognize that he must put up with objective necessities, things that are really beyond the control of his company or boss. The very nature of the work situation is such that it requires that certain things be done. That is, as the man can be made to see that, he will accept the burdens that work involves. *(Editor's note: the work situation involving overlapping interests is shown by the diagram on the next page.)* Each of us has our own interests that are incompatible with the others. The employee has certain personal needs which conflict with the needs of the company and the supervisor, but fortunately there is an area of overlap among the needs. There is a coincidence of interests at different points. To motivate a man you have to find the area of overlap between his interests, those of his supervisor, and those of the company.

Is it easier to indicate to research workers and engineers how their work contributes to mutual interests than lower-level employees?

In every profession it's easier. In fact, by very definition, the quality of professionalism presupposes that the man has an inner need to function in the activities that characterize the profession. That being true, it is easier for a man who is in the field of science or engineering to recognize the ultimate value of his work. In addition to that, there is a sense of dignity and status that attaches to what he is doing. There is the hoped-for recognition from society that he performs an important function. Now when all of those things are systematically coupled, if there is a systematic effort to regard the man's status, show him the awareness of

more on next page



To motivate and supervise a member of your staff properly, determine the areas of overlapping interest, as shown at right. Chart reproduced courtesy of Research Institute of America.

his status, and to make sure at the same time that at every stage of the game he understands what the end product of his labor is going to be, he'll be a motivated man. Let me give you one illustration of how the status is not recognized. An aircraft manufacturer recently ran an ad which had a picture of draftsmen sitting at long rows of tables at work. They ran under it the caption, "An Acre of Engineers."

With the unfortunate implication you can get them by the acre.

Yes! And that's the kind of thing that management systematically should be avoiding. It's a reduction of the man's status uniqueness instead of a recognition of his real contribution.

Can you give me any examples of companies that are successfully giving status to their engineers and scientists?

In recent weeks, I've seen the highly intelligent effort of one company, duplicating what the "New York Times" has begun to do. The "Times" has been taking individual correspondents and newspapermen and running full page ads about them, such as Harry Schwartz, their expert on Soviet affairs, or James Reston of their Washington Bureau. I've seen one company doing that with reference to individual engineers. It was selling the company, and the backbone of the company, it said, is the engineer, the man with technical knowledge. And there is Joe Smith, it said, and it gave you a picture of him, a description of his background, his education and his training, as evidence of the quality of the company's performance. Now there was a raising of the man's status.

You think this is of just as much importance to the employees of the company as to the customers?

Right! In fact one of the sad things in American industry is that it spends so much more on trying to build good relations with the public than it does on building good relations with its own people.

What techniques can be used to build up the relations of the company with its own employees? How do you feel about the use of house organs?

Well, the art of publishing a house organ is in itself quite an extensive subject. A house organ should do many things. It should carry news of individuals, but it should also serve as the medium through which the company demonstrates its attitude of acceptance and concern with the welfare of its employees. If it merely becomes a gossip sheet, it has little weight. But the kind of recognition that a house organ can give to its employees in terms of their achievement, in terms of identifying them with customer satisfaction, that kind of thing has real meaning in the human relations sense. If the organ is intended just to glorify the company to the employees, it is not going to be successful—at least, not in achieving that result.

How do you motivate scientists who have very little to do with the company's products?

Well, you've got two different groups to think about. Of course, there's the pure scientist who does not see himself in relation to a given product. In fact, I suspect that the type of temperament that goes into pure science is one that does not want an identification with a product, but with the ideas that emerge. He wants recognition in terms of the contribution that he makes not to a product, but to the advancement of knowledge. That's why being a Nobel prize winner is such a significant thing to men who are seemingly hermits isolated in a laboratory. I would say that by-and-large the problem of motivation is not difficult in that area. These men experience the satisfaction of their inner needs—the element that I underscored in my definition of human relations. They are motivated almost automatically just by the opportunity to claw at the veil that keeps knowledge from our eyes. But they do want recognition and identification with the end result of their exploration. It may be that we are heading for a problem in terms of the kind of research project that's broken up into a series of small units; each man has one little element that he's pursuing without a sense of closeness to the whole. If you get that kind of division of labor in the field of pure science, then I think you will also wind up with the problem of the unmotivated scientist.

But take the scientist who is working in an applied field. I think he faces very much the same kind of pressure as the average individual who is divorced from his work. Except for one thing . . . he begins with a sense of identification with the process, he has, by virtue of his professional standing, an emotional involvement to begin with, so that it is easier to give him the satisfaction because you know what kind of satisfaction he has started out to look for.

Then I think you would endorse the practice of many companies of allowing their professional people to go to meetings and talk about the results of their work?

That's right! Encouraging the man to participate in the work of his professional society, getting him as often as possible outside the company's walls for contact with other researchers at one and the same time contributes to his sense of status, his sense of uniqueness as an individual with the company. It also contributes to his efficiency in performing his job because he widens his horizons.

Motivating Youngsters to Go into Science

Now, let's go to the other end of the scale, getting or motivating youngsters to go into engineering and science. Are you familiar with the Purdue University and other studies which indicate that high school students generally do not want to study science?

Yes, I am familiar with that, and I think that there have been a number of explanations. One of them I have not seen advanced anywhere else. Maybe at this juncture, we should treat it only as theory. Generally I find that people explain the inability to attract large numbers of youngsters on the basis of this kind of thing. To begin with, there is a deficiency in the amount of mathematics they have had when they get through with high school, so that when they get to the point of decision, when they are ready to choose what career they will actually go into, they're behind the eight ball because they are lacking in one of the essentials, such as mathematics, to qualify them to begin to take a B.S. degree—if that's what they're going to go for. Certainly for an engineering degree they need mathematics. So that one of the visible evidences of their failure to go into science can be found in the fact that through their high school years they have not been taking mathematics.

(Continued on page 31)

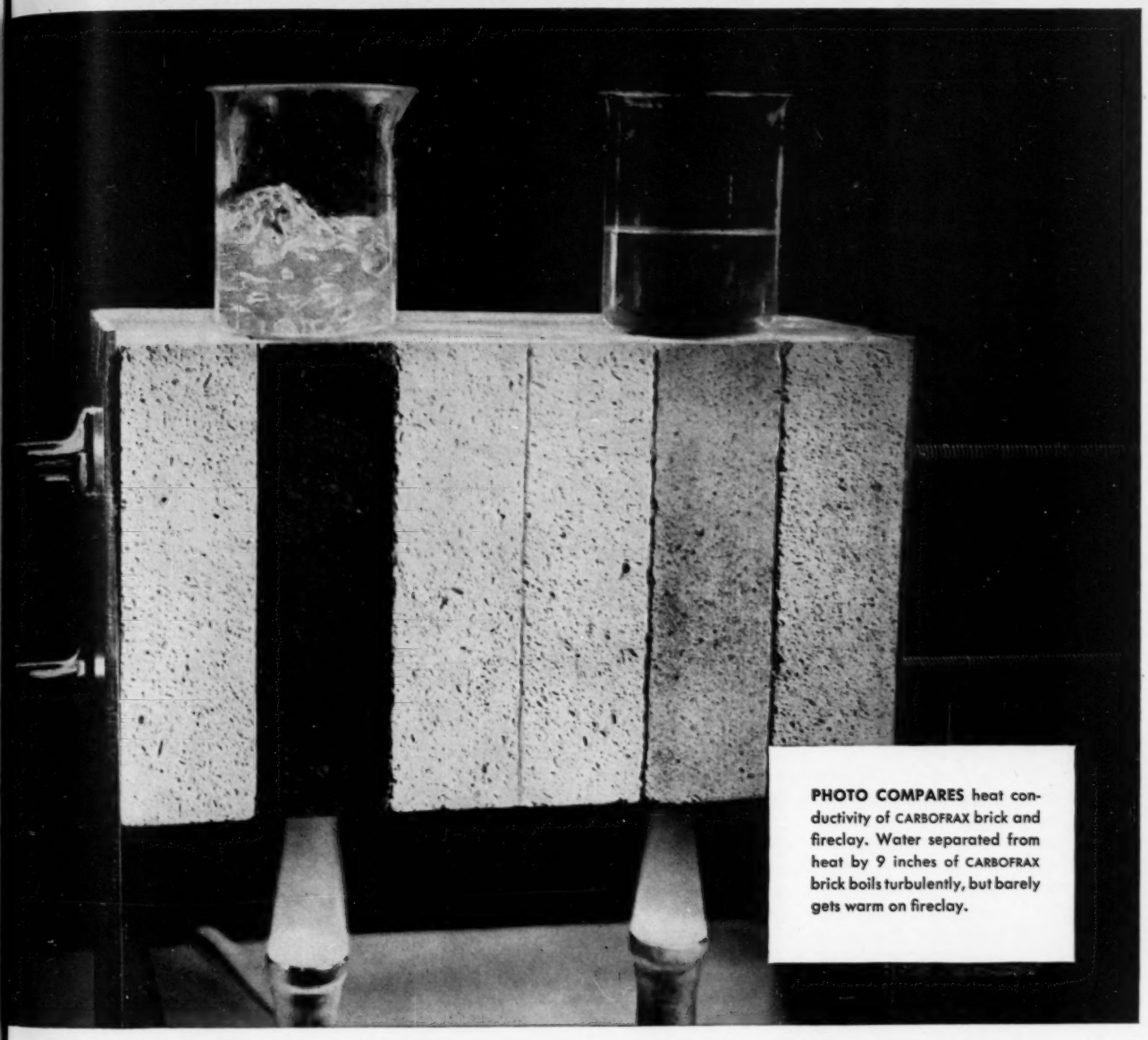


PHOTO COMPARES heat conductivity of CARBOFRAX brick and fireclay. Water separated from heat by 9 inches of CARBOFRAX brick boils turbulently, but barely gets warm on fireclay.

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CARBOFRAX refractories typify the many super refractories pioneered by Carborundum. Each has a wide range of properties. One, for example, is formed into precision parts that look like cast iron yet resist over 3000°F. Another, a new ceramic fiber, filters and insulates at temperatures no existing mineral or glass fiber can take.

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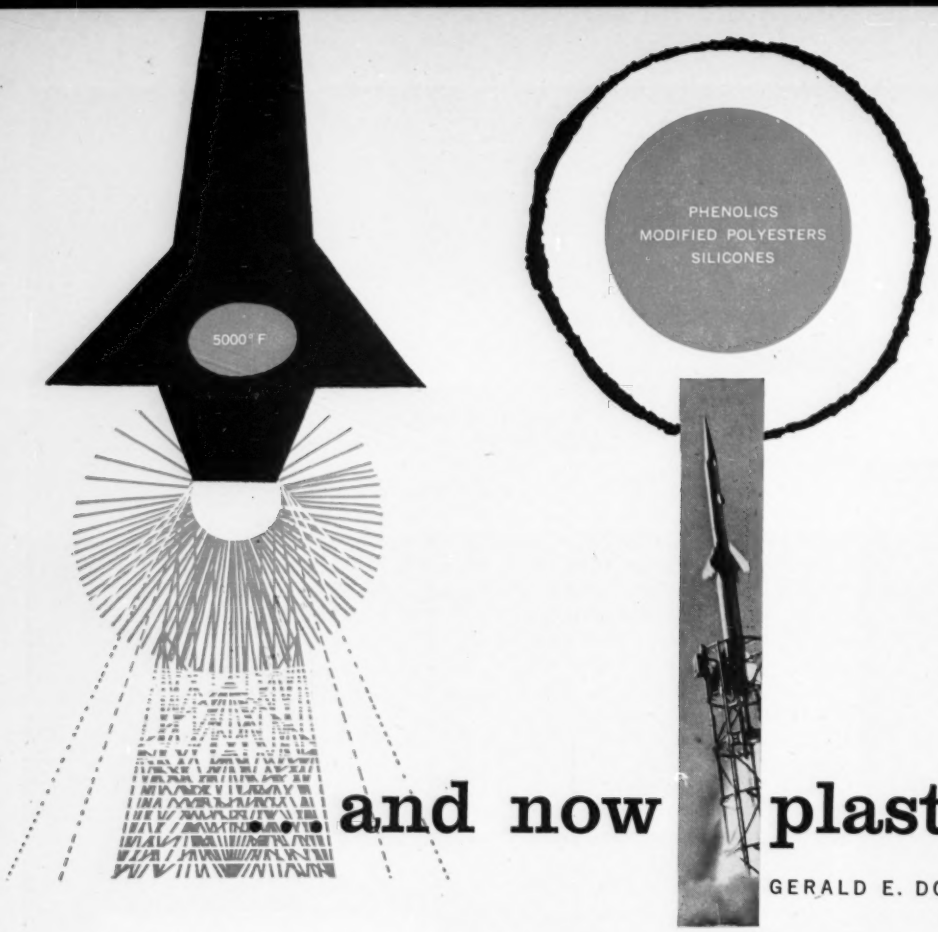

... and now plastic missiles

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We have the manufacturing skills to produce complete missiles of laminated materials.

These laminated plastics are an answer to the urgent and growing demand for materials that will withstand temperatures in the order of 2-5000°F. Most metals melt somewhere in this range, and such temperatures are certainly far beyond the *long-time* resistance of any plastic material—including the irradiated materials.

But when the problem is considered in terms of *short-time* exposures to these extremely high temperatures, other possible solutions emerge. Among these are plastic laminates.

Three families of plastic resins in current use are capable of short-time exposures in these high temperature environments. These are the phenolics, the silicones, and the modified polyesters.

The Big Three

The first of these, the phenolic resins, are a reactance product of phenol and formaldehyde. Modification of the reaction, and the introduction of other materials during it, creates an astonishing number of resins, all of which are called phenolics. About four of these are in common use in high temperature applications. In all cases they are limited in extended service to temperatures not exceeding 500°F; but they have a short-time applicability in temperatures in the order of 4500°F.

The silicone resins, the second of the three, are comparatively new to the laminating field. More difficult to process than most plastic resins, they are made from organic silicone compounds. Their low mechanical strength at room temperatures has discouraged many applications of silicone resin laminates. But their strong points assert themselves when submitted to long-time service in excess of 500°F; and their physical properties hold pretty well up to 700°. They have proved themselves in brief exposures up to 5000°F, under pressures of 20 to 30psi.

Finally, the modified polyesters — thermosetting alkyd resins dissolved in styrene. The high temperature polyesters are a group of unsaturated alkyds combined with triallyl cyanurate or some similar material. Physical performance of these polyesters is slightly below that of the phenolic resins. Their surfaces are usually much smoother than the phenolics or the silicones—a feature which should increase the erosion resistance of their laminates. About 3000°F is their short-time service limit.

Reinforcing Materials

These resins, of themselves, are unsuited to high temperature applications. It is when they are reinforced that their striking qualities for very high temperature, short-lived uses emerge. Among the reinforcing materials are glass fibers, asbestos, and chemical and natural quartz fibers.

Glass fibers, larger than the other three, are the most commonly used reinforcement. They have good tensile strength, and their larger size gives them better resistance to erosion at high temperatures. The glass fibers do not break-down in temperatures short of 2000°F.

Asbestos fibers are smaller than glass, permitting a higher fiber-to-resin percentage in the laminate. This means that the laminate has greater density, which offers advantage in dealing with the erosion problem.

High-pressure molded phenolic resin laminates have been used successfully in guiding vanes for rocket motors where, for two minutes, temperatures exceed 4500°F.

Medium-pressure molded isotropic nose cones have been used at high Mach numbers where temperatures have exceeded 750°F for half-an-hour.

Fin units on booster motors have resisted 2400°F at high Mach numbers for a full minute.

These brief times are at least equal to the high-temperature blast durations of rockets. And though the laminate may in some cases be seriously scarred by the blast, a core of the material yet remains that is of sufficient strength to maintain the integrity of the structure.

Asbestos fibers have a further advantage: their composition includes a relatively high percentage of water. The higher water content requires more heat to break-down the fibers. Thus their service time at extreme temperatures is increased.

Chemical quartz fibers, available in many sizes, are made of chemically leached glass. The leaching process introduces additional water into the fiber. This allows engineers to combine the greater resistivity of water and the desirable characteristics of larger fiber size. Thus the lower physical strength of this material, as compared with glass or asbestos fiber, is offset by a much higher temperature resistance than either of the others.

Natural quartz fibers have good physical properties and high water content. But present manufacturing techniques produce fibers so small in diameter that it is not yet possible to make strong laminates from them.

Manufacturing Methods and Techniques

The manufacturing methods by which the resins and reinforcement materials are combined in high-temperature laminates are idiosynchratic to each combination. They are in outline:

The Vacuum Bag Lay-up employs a mandrel and vacuum bag. It is the cheapest way to produce prototype or experimental parts. But the 15psi maximum pressure available to this method produces laminates of fairly low density which, more rapidly than high pressure products, deteriorate in extreme temperatures.

To achieve the maximum density possible with the Vacuum Bag Layup Method, each ply of the laminate must be laid down securely by either ironing in place or by applying the material to the core under pressure. Sufficient bleeder and breather materials must be used to permit the escape of volatiles and excess resin, given off during the cure of most plastic resins. Too rapid curing increases the possibility of delamination from steam.

The Shrinking Film Technique can be used only for certain shapes where a shrinking film can produce an even pressure. The 45psi pressure applied by this method produces a denser laminate than does the Vacuum Bag Lay-up.

Shrinking films are limited to shapes that have enough curvature that the film is always in contact with the laminate. Here slits or overlaps are used to allow gases and volatiles to escape.

Matched Metal Low-Pressure Molding employs matched dies to produce parts. Laminates made this way have greater density since the molding pressures are generally between 100 and 200psi. The dies must be designed, and the curing cycles calculated, to prevent uneven composition of glass and resin.

Interesting possibilities are offered by low pressure molding in matched metal dies. Preformed patterns can be laid up in any manner prior to curing. And very high density parts may be made by using the Kiss Technique. This consists in bringing the heated press into contact with the material without applying pressure. The resin becomes watery and then starts to thicken or gell. When gellation starts, full pressure is applied. The Kiss Technique allows the excess moisture and the volatiles to be boiled out of the resin. Reduced porosity and better physical properties result. But the successful use of this technique depends upon the temperatures used, the length of time they are used, the age and volatile content of the resin, and the catalyst percentage—and for these there are no set rules.

Compression Molding produces the best erosion resistant laminates. Parts produced by this method are uniform and very dense. But the high cost of tooling to the method, and the costs for presses capable of producing pressures of 1000 to 8000psi, are disadvantages.

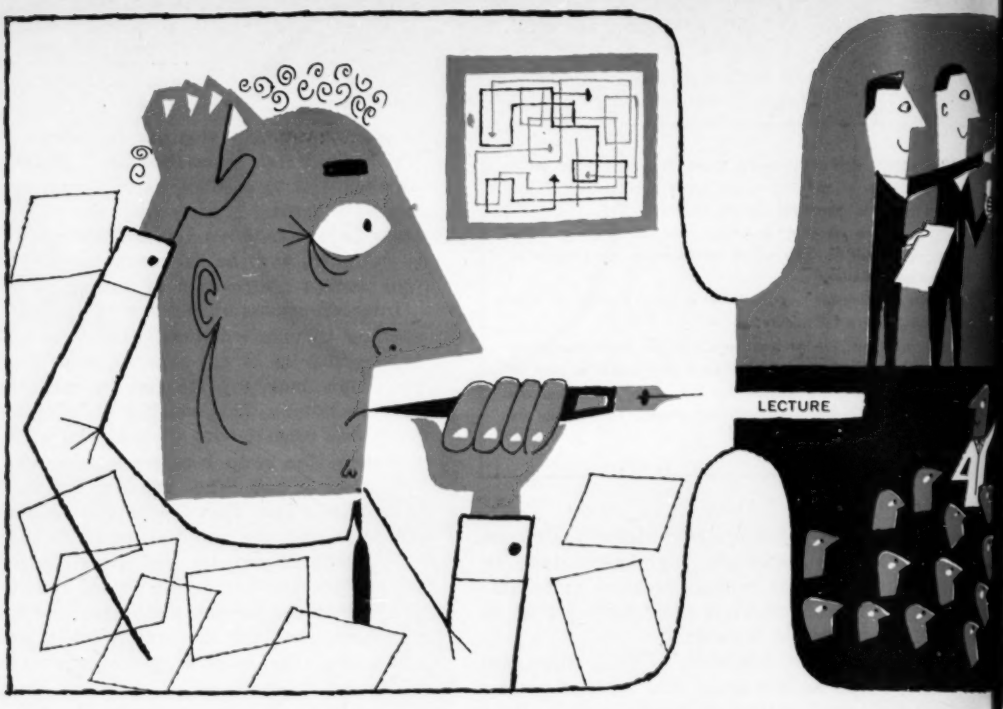
Transfer Molding and Injection Molding are two alternative methods used to produce plastic materials. They are capable of very high production rates and produce fairly uniform parts, but they do not produce what are generally considered to be laminations.

Performance

Burn-through tests have proved that most types of plastic laminates are able to exceed the service life of metals when the temperatures involved exceed the metals' melting point. Underlying the superiority of the resin plastics discussed here is their low thermal conductivity. Though they will burn at temperatures far less than 2000° to 4000°F, the laminate itself must be heated to its combustion point before it will burn. Since they are slow to heat and have poor conductivity, these laminates tend to burn in layers. And so a part need be made only of enough material so that a core is left after exposure to high temperatures.

Indicated now are further studies in design techniques and burning rates, and in high temperature effects upon laminated panels under combined loading. But enough is now known of these high-temperature short-lived plastic laminates for us to attempt construction of an all-plastic missile. It remains only for our designers to become sufficiently well acquainted with the new processing and manufacturing techniques; for, in order to best exploit the physical characteristics of these materials, they must depart from the familiar methods of metal fabrication. END

Mr. Dodson is Chief Engineer of the Reinforced Plastics Division of the H. I. Thompson Fiberglass Co., Los Angeles, Calif. *The Material of this article was presented before the American Rocket Society. The information used has been culled from many sources.*



Engineer-writers are made not born

Robert R. Rathbone

The enormous growth of industry and technology has been exceeded in quantity only by one other activity—writing. Reports, proposals, memoranda, articles, all are required by a product: and all—in sheer volume—outweigh it. The demand for writers is greater than the supply; and engineers and supervisors are drafted to stop the gap. Here is a program to help correct the literary deficiencies of the draftees.

Technical reports are greeted as much with anguish as with anticipation. Anticipation because they are frequently the only tangible products of costly engineering projects. They are the evidence upon which management must rely for its understanding of what a company has done, what it is doing, and what it ought to do. And anguish because they consume an increasing part of the expensive time of engineers, supervisors, and department heads—both in writing and reading them and they are usually badly written.

If the reports that cross your desk are confused, ungrammatical, or just plain deadening, it would be well to hire a technical editor to handle those of top priority. But it will also pay dividends to get to the source of the trouble. Here are some ways to help the authors help themselves—a program that will be more economical to the company in the longer run and that will enhance the value and morale of your staff.

Stimulate Interest

Lack of interest in writing keeps most engineers from improving. You can stimulate interest with occasional brief and friendly talks on the importance of good writing. Start by telling your engineers how the company uses its technical reports, how much the reports cost, who the readers are, and what kinds of information are needed. A company directive on the subject will satisfy the record and prove a valuable reference. But don't depend on it to have the force of a personal message.

Keep interest alive by arranging talks by other staff members. Here are some possible subjects: *Writing Journal or Magazine Articles; That Necessary Evil, The Progress Report; How to Dictate—at Home and in the Office; Effective Use of Visual Aids in Reports.* It's best not to have a set interval for these talks but to hold them when the topics have some relation to current activities in the plant, or when the work load permits. You might try enlisting outsiders

to give the lecture series wider appeal. Editors of trade magazines or professional-society journals, roving authors, and technical writing experts are usually available.

Use Existing Talents

If you already have a technical editor, don't make him spend all his time rewriting manuscripts. Encourage him to attend project meetings and to talk with your potential authors. Insist that he teach basic principles, simply and informally. If necessary, give him an editorial assistant; so that his more valuable skill won't be squandered on the red pencil and the paste pot. And give him the status he needs to crack the engineers' conclaves unresented.

In the absence of a technical editor, the supervising engineers—i.e. group leaders, project leaders, etc. should assume full editorial responsibility. They are the key men in any improvement program. In daily contacts and conversations with their men on engineering matters, the supervisors are in an excellent position to help solve writing problems. Here are just a few of the things they might do: Plan the writing and the engineering together—the first is a phase of the other: Assign reports early in the project.

- Tell the engineer-authors what the objective of the project is, who the intended readers are, and how to slant the message.
- Insist that every report first be outlined; check the outline for coverage and organization.
- Schedule sufficient project time for report writing.
- If possible, provide the author some privacy.
- Hold frequent editorial conferences.
- Return manuscripts promptly, while your criticisms, and the author's, are still fresh.
- Be explicit in your criticisms of writing. Demonstrate improvement by specific illustration, not by rewriting an entire report or section.
- Give full credit for authorship; never ask an engineer to ghost write. This is extremely important. If you give him credit, you enlist his pride—a better job will result.
- Work closely with the technical editor; agree on a uniform editing procedure and policy.

Supplement With Outside Assistance

Teaching Aids. Since the supervisor-editor must be ready to explain why certain usages are wrong and in poor taste, and must be prepared to show the author how to correct errors, he should have some practical teaching aids—an editor's notebook for example. Other aids might include before-and-after versions of tables and curves; sentences exemplifying various errors in grammar and punctuation, and the corrections; the originals and revisions of some windy passages; sample abstracts, informative and descriptive; and one or two pages showing effective use of headings. Live ammunition from company reports is excellent. Better still are samples of poor writing from a competitor's report.

Another editorial teaching aid, which involves some effort but is extremely helpful, is the conference file. In this, the supervisor records general criticisms of the reports he edits, including notes on the kinds of errors each writer makes. By accumulating such information, he can evaluate the effectiveness of past instruction in relation to present performance, and plan his editorial conferences accordingly. The form of the record is unimportant; 3 x 5 cards serve well.

Encourage uniform editing by supplying all editors with a check list that presents an organized plan of attack, breaks the editing job into easy-to-handle parts, raises questions about organization, coverage, and grammar; and supplies examples and references. Ask a professional editor to help you prepare this guide. You won't regret the small cost.

(Continued on page 43)

how R/E covered the manageme
of product a ces
EXECUTIVE HEALTH
LIMIT THEOREMS
Practical Tool for Project Evaluation
Research and Resources in the South
TIME MANAGEMENT FOR THE RESEARCH EXECUTIVE
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How's Your Organizational Quotient?
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2. **Research and Resources in the South**—by Frank S. Soday

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3. **Limit Theorems:** Practical Tool for Project Evaluation—by Hilary Moss
4. **Time Management for the Research Executive**—by Luis J. A. Villalon
5. **Human Engineering**—by Robert B. Sleight

MARCH
6. **The DP Problem:** How to Handle the Difficult Person in Engineering by Luis J. A. Villalon
7. **Economics Research in Development Programs**—by John Rivoire
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MAY
11. **How Do You Rate As An R/D Manager?**—by David A. Emery
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13. **Research and Development for Profit**—by Melvin Mandell
14. **Design Time and Money**—by Gerson Friedman and Isaiah Eisen

JULY
15. **Planning A Research Information Center**—by Herman Skolnick
16. **The Challenge of Frontier Products Research** by William E. Hill and Warren B. Riley
17. **The Formulation of Problems in Research**—by Alfred M. Freudenthal

AUGUST
18. **High Temperature:** Tool for the Future. This was R/E's special issue, devoted almost entirely to all phases of high temperature in research, development and production, based on R/E editor's attendance at Symposium on high temperatures at Berkeley, Calif.

SEPTEMBER
19. **Government R & D Contracts:** Pitfalls and Procedures—by Max Hoberman
20. **Water:** A Review of Its Economic Importance in Industry by Ronald C. Vickery

OCTOBER
21. **Research Control**—by Ronello B. Lewis
22. **Creativity in R/D Teams**—by Herbert A. Shepard

NOVEMBER
23. **Wall Street Looks at R/D**—by Ora C. Roehl
24. **The Cause and Cure of Executive Insomnia**—by Luis J. A. Villalon

DECEMBER
25. **How Much Is An R/D Boss Worth?**—An R/E Survey—by Scott Nicholson
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No. of Article	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Liked exceptionally well														
Very interesting														
Extremely helpful														
Helpful background stuff														

No. of Article	15	16	17	18	19	20	21	22	23	24	25	26	★
Liked exceptionally well													
Very interesting													
Extremely helpful													
Helpful background stuff													

HERE'S MY VOTE FOR 1957

General subjects of interest_____

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Particular subjects would like to hear about_____

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Additional comments_____

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YARDSTICKS

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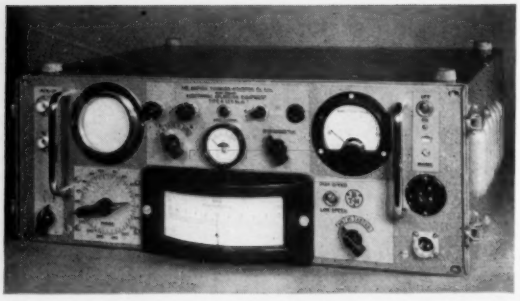
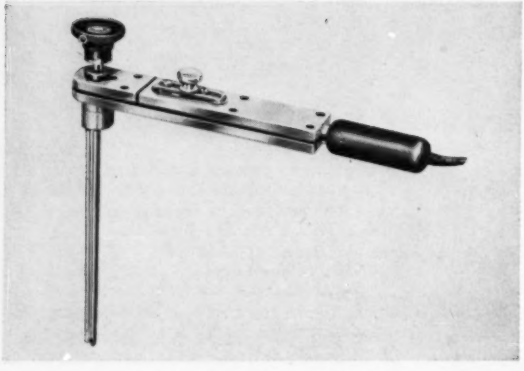


Electronic Balancing

Rotating machinery can be accurately balanced at the site by using this Type 4 equipment. It can be employed on machinery rotating at speeds as low as 100 rpm. British Thomson, Houston Co., Ltd., Rugby, England.

FOR MORE DATA CIRCLE 11 ON PAGE 48



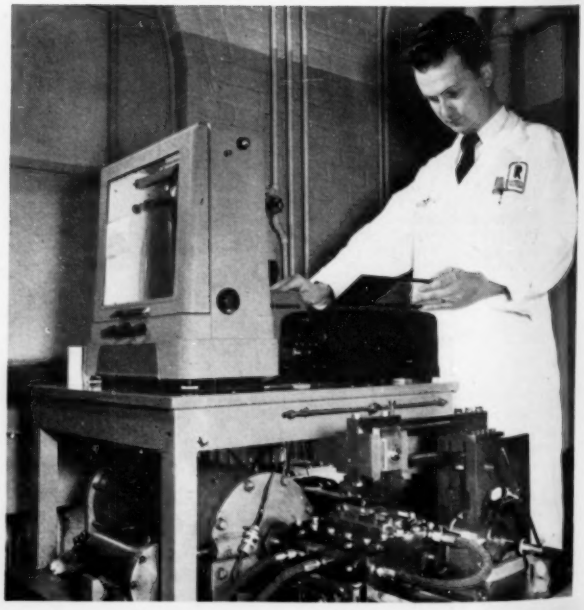
Looks in Small Holes

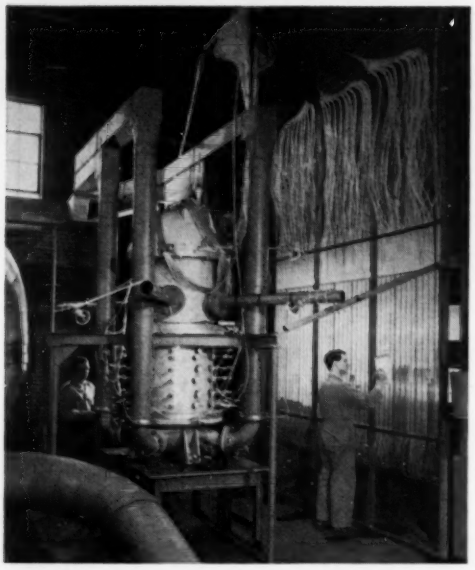
The lens in this needle-like instrument is smaller than the head of a pin in some cases. The instrument can detect flaws, dirt or erosion in small tubes and cavities with diameters down to 0.160". Each borescope is supplied with four tubes affording vision directly forward, obliquely forward, at right angles to the bore, and obliquely backwards (55°). Kollmorgen Optical Corp., 347 King St., Northampton, Mass.

FOR MORE DATA CIRCLE 12 ON PAGE 48

On the Ball

This elaborate apparatus helps to tell why a hard rolling bearing ball stops rolling on a hard level surface. It was designed by physicist Richard Drutowski (shown in photo) of the General Motors Research Staff. The device measures rolling friction as affected by such variables as materials of the ball and surface, their roughness, hardness and other minute factors that govern so-called rolling friction losses. From this information it is possible to predict what losses will occur, depending on what types of metals are used in balls and surface plates on which they roll.



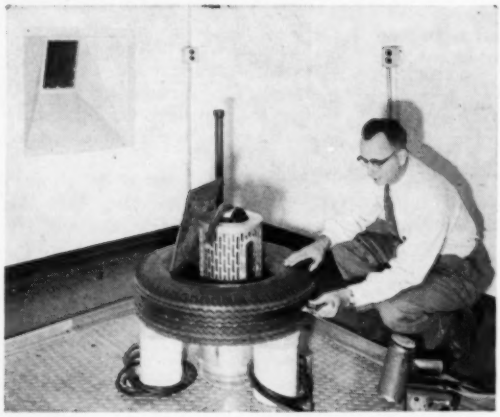


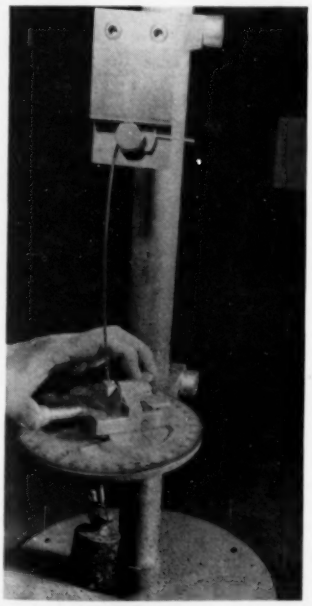
Model of Efficiency

Fluid-flow studies conducted on this quarter-scale model of a nuclear power reactor will tell whether the cooling fluid will circulate properly and adequately cool all parts of the reactor. On the manometer board at the right, Battelle Memorial Institute technologists measure the liquid level, and thus the air pressure, at 350 separate points throughout the model. The full scale reactor is a 60,000 kw job being constructed for the Duquesne Light Co. by Westinghouse. In the model, air simulates water as the cooling medium.

Tired Tire

Dr. S. D. Gehman of the Goodyear Tire & Rubber Co. tests tire tread hardness following exposure of the tire to intense gamma ray radiation. Cobalt 60, source of radiation, is raised from bottom of 17-foot well into aluminum housing in center of tire when irradiation experiments are to be conducted. Window at upper left is 36 inches thick, made of optically polished high density glass and permits scientists to see into irradiation chamber or "cave" while various materials are irradiated.





Wire Tester

These two photographs illustrate the two main steps in measuring the torsional elastic limit of spring wires with a newly designed tester. On the left a measured test length of wire is twisted manually to a given degree of deflection, then released. At the right, the amount of angular deflection which remains after the twisting load is released is the torsional set of the wire. The twisting action is repeated with increased deflection in regular steps until the set exceeds 2% of the deflection. Associated Springs Corporation, Bristol, Conn.

FOR MORE DATA CIRCLE 13 ON PAGE 48

THE PLENTIFUL RARE EARTHS

some facts about a clubby clan of elements that are rare in name only

a report by LINDSAY

We got to thinking the other day that perhaps a lot of industry folks are passing up a diamond-studded opportunity because they believe the rare earths are unavailable in commercial tonnages. Nothing could be farther from the truth. Rare earths are *not* rare! Commercial salts of the rare earths are available, right now, for prompt shipment in quantities from a gram to a carload.

That the rare earths are so plentiful is due, in large part, to Lindsay. During the last 50 years, Lindsay has developed the extraction and separation of rare earths to a high degree.

New equipment and processes are now in operation at Lindsay's West Chicago plant and are producing greater quantities of these versatile materials in higher purities than before.

FROM 57 THROUGH 71—Some chemists call rare earths Lanthanides, Lanthanons or the Lanthanum Series. Actually they are not earths, but trivalent metals, a rather amazing family of elements . . . atomic numbers 57 through 71. They are grouped together because they are always found together, with thorium and yttrium, in ores such as monazite, and all have closely related properties. While rare earths are technically metals, Lindsay produces them in chemical salt forms—individually or in combinations.

ATOMIC NUMBER	ELEMENT
39	Yttrium
57	Lanthanum
58	Cerium
59	Praseodymium
60	Neodymium
62	Samarium
63	Europium
64	Gadolinium
65	Terbium
66	Dysprosium
67	Holmium
68	Erbium
69	Thulium
70	Ytterbium
71	Lutetium
90	Thorium

SOME USES FOR RARE EARTHS

LANTHANUM—As lanthanum oxide in a high refractive optical glass, particularly for aerial cameras and other instruments.

CERIUM—Glass polishing. Scavenger in explosives production. Radiation protection glass for atomic reactors. Opacifier for porcelain. Oxidizing catalysts in organic preparations. Ultraviolet light absorber.

MIXED RARE EARTHS—Misch metal for lighter flints and alloy uses Motion sickness medication. Cores of arc carbon electrodes. Aluminum and magnesium alloys.

PRASEODYMIUM & NEODYMIUM—Dichroic colorants for ceramic glazes and glass. Used in better grade sun glasses. They do not lower light permeability and index of refraction when used as colorant or decolorizer. Ceramic capacitors.

The rare earths are becoming increasingly important in the production of steel and steel alloys. Small quantities added to the metal in the ladle result in a strong, fine-grained steel. Steel thus treated has great resistance to low temperature oxidation and corrosion. Stainless varieties have better hot and cold workability. Silicon and electrical grade steels have better electrical qualities.

Rare earths added to cast iron act as powerful deoxidizers and help remove sulfur from the molten metal. They are responsible for cast iron that is resistant to scaling at higher temperatures and to certain corrosive atmospheres. In malleable metals, they act as a carbide stabilizer.

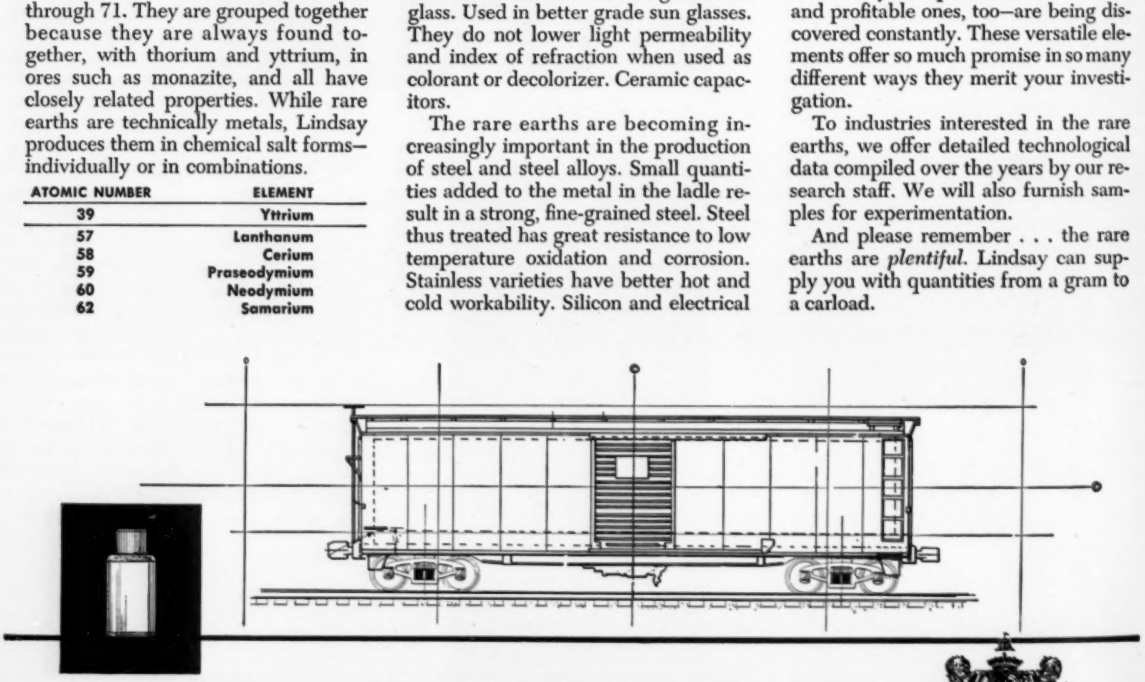
Magnesium-rare earth-zirconium alloys have excellent casting qualities and mechanical properties that make them ideal for important light-weight stressed components of aircraft engines.

Other rare earth compounds are used extensively for waterproofing, mildewproofing, weighting and dyeing of fabrics and compounding printing inks and phosphors.

LIKE AN ICEBERG—You might compare uses for the rare earths to an iceberg. What you see is only a small part of what lies undiscovered under the surface. In all probability, there is a real place for one or more of the rare earths in your operations. New uses—and profitable ones, too—are being discovered constantly. These versatile elements offer so much promise in so many different ways they merit your investigation.

To industries interested in the rare earths, we offer detailed technological data compiled over the years by our research staff. We will also furnish samples for experimentation.

And please remember . . . the rare earths are *plentiful*. Lindsay can supply you with quantities from a gram to a carload.



PLEASE ADDRESS INQUIRIES TO LINDSAY CHEMICAL COMPANY

274 ANN STREET • WEST CHICAGO, ILL.

Did your Education educate you?

All engineers encounter problems in the field that were not anticipated in the R/D lab. How well did the lab of your formal education prepare you for the field? Here's how 13,000 GE engineers and non-engineers rate their four years in college.

How well has your education served you? Has it contributed as well as it might have to your professional skills?—to your leisure time? Would you take the same courses now that you know better?

These are some of the questions General Electric put to their college-graduate employees. Purpose: to test and revise GE's machinery for recruiting and manpower mobilization; and to help higher-learning institutions plan their curricula. Here is an outline of GE's questions and findings.

• • •

Managerial, professional, scientific, secretarial, and clerical employees, who hold college degrees were queried. Over 13,000 questionnaires were processed. They were about equally divided between engineering and non-engineering graduates.

The respondents considered four subject areas in the college curriculum to be extremely valuable in contributing to career success. Regardless of their academic background or type of employment, the respondents put English communication—both written and oral—high on the list. Non-engineering people placed this subject first; engineers rated it second only to Mathematics, which is also a communication tool. Other subject areas that both groups reported as important for career success include Physics, Economics, and Mathematics.

From a career standpoint alone, they judged History, Foreign Language, miscellaneous sciences like Biology, Botany, Geology, etc, and certain social sciences (principally Government and Economics), to be the least valuable subject areas. They indicated that the techniques of teaching certain courses left much to be desired, particularly in the social science area, where, they felt, attention was often directed to theory at the expense of practical applications.

The program of studies contributing most to success in a business career, according to those polled, was almost equally divided among the four major study areas: Sciences, Social Sciences, Humanities, and Business. Survey respondents agreed that a good collegiate program for business management training should include basic work in English, Science and Engineering, Mathematics, Economics, and General Business: though they differed in the order of importance. Liberal-arts graduates also stressed the fundamental value of work in Psychology and the Humanities.

All of this can be interpreted as a strong vote of confidence for a broad liberal education. In general, the respondents seemed to value the broad liberal-arts background for personal and career development, with specialization, if essential, occurring at the graduate level. Any program of real benefit for industrial responsibility must include developing a high measure of skill in communication and in human understanding.

Questions, Answers, Analyses

What areas of college study have contributed most to your present position of responsibility with the General Electric Company?

The great majority of Non-engineering Graduates reported English communication, written and spoken, to be the most helpful and valuable subject area. Many went to some length to comment on the importance of an individual's ability to communicate easily and clearly. Engineering Graduates, on the other hand, put English second to Mathematics in importance. The inference is that both study areas tend to provide communication skills so essential to modern business success.

What areas of college study have contributed least to your present position of responsibility with the General Electric Company?

In the order of citation, the consensus among career engineering graduates was: 1) Foreign Language, 2) History, 3) Engineering, 4) Economics, 5) Government, 6) Chemistry, 7) Literature and Mathematics (tied), 8) Miscellaneous Sciences.

The non-engineering graduates considered the least valuable courses to a career to be: 1) Foreign Language, 2) Miscellaneous Sciences, 3) History, 4) General Business, 5) Accounting, 6) Economics, 7) Mathematics and Physics (tied), 8) Government.

What areas of college study have contributed most to your use of leisure time?

Engineering graduates replied, in order: 1) English Literature, 2) Engineering, 3) History, 4) Economics, 5) Physics, 6) Mathematics and Philosophy (tied).

Non-engineering graduates said: 1) General Business, 2) History and Science & Engineering (tied), 3) English Literature, 4) Mathematics and General Humanities (tied), 5) Economics, 6) Physics and Philosophy (tied).

(Continued on page 38)

MATERIALS

Super-Strong Magnets

Working with pure iron particles that are so small they are invisible, researchers at General Electric's Instrument Department, Lynn, Mass., have produced experimental magnets that are potentially 10 times stronger than the best available magnets. The ones made already are equal to the best commercial types. A variety of magnet shapes is possible, because the elongated particles can be imbedded in plastics, rubber or glass. Since there is no cobalt in the particles, these magnets can be used in nuclear reactors.

Teflon Tubing

Teflon tubing is now available in AWG wire sizes of 0, 1, 2, 3, 4, 5, 6, 7, and 28 and 30. The thin wall tubing has a minimum dielectric strength of 750 volts/mil. All sizes are made in 10 coded colors. The Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Pa.

FOR MORE DATA CIRCLE 46 ON PAGE 48

High-Temp Grease

This chlorofluorocarbon grease has grease-like characteristics in a temperature range of 20°F to 275°F. Above this temperature, it has characteristics of a clear oil up to about 550°F. It has been used to lubricate plug-cocks where other materials failed because of chemical reaction or insufficient thermal stability. Halocarbon Products Corp., 82 Berlews Ct., Hackensack, N. J.

FOR MORE DATA CIRCLE 47 ON PAGE 48

High-Temperature Tape

Made of fiberglass, this printed, pressure-sensitive adhesive tape effectively keeps its bond to 550°F. It also performs well at low temperatures and has superior electrical properties. Available in widths from ¼" to 2", and your information can be printed on it in one, two or three colors. Topflight Corporation, Dept. "G", York, Pa.

FOR MORE DATA CIRCLE 48 ON PAGE 48

Aluminum Extrusions

A barrier to the wider use of inexpensive aluminum impact extrusions has been lifted. Products made by this technique are now available with a thin surface coating which provides cathodic corrosion protection, facilitates finishing, or makes joining easier. Applications in the process industry where corrosive solutions or atmospheres are severe and in small water tanks, steam traps and electrical cases are now possible. Aluminum Company of America, 1501 Alcoa Building, Pittsburgh 19, Pa.

FOR MORE DATA CIRCLE 49 ON PAGE 48

Carbon-14 Compounds

Research chemists and allied professionals will welcome these 16 new carbon-14 labeled compounds. These radioisotope-labeled chemicals range from barium carbonates to silicone oil methyl. Tracerlab, Inc., 130 High Street, Boston 10, Mass.

FOR MORE DATA CIRCLE 50 ON PAGE 48

Protective Coating

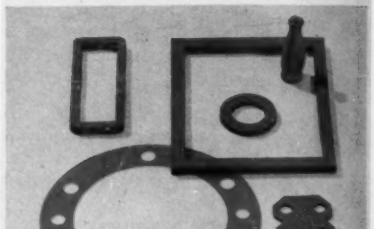
Resistant to many acids, bases and metallic salts, this vinyl-based coating also provides excellent protection for metals against moisture and corrosive fumes. Adding chemically stable pigments offers coatings which are also decorative. An adhesive plastisol primer is recommended for use with the coating to assure maximum adhesion to metal surfaces. Goodyear Tire and Rubber Company Chemical Division, Akron 16, Ohio.

FOR MORE DATA CIRCLE 51 ON PAGE 48

Prevents Rubber Cracking

These two antiozonants retard deterioration and cracking of rubber products from GR-S (butadiene-styrene and other elastomers). They are called Tenamene 30 and Tenamene 31. Development of these products has come as an outgrowth of an intensive research program which firmly established that ozone, rather than sunlight, was the principal cause of rubber deterioration. Eastman Chemical Products, Inc., 260 Madison Avenue, New York 16, N. Y.

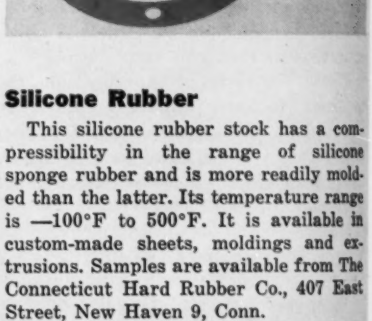
FOR MORE DATA CIRCLE 52 ON PAGE 48



Silicone Rubber

This silicone rubber stock has a compressibility in the range of silicone sponge rubber and is more readily molded than the latter. Its temperature range is —100°F to 500°F. It is available in custom-made sheets, moldings and extrusions. Samples are available from The Connecticut Hard Rubber Co., 407 East Street, New Haven 9, Conn.

FOR MORE DATA CIRCLE 53 ON PAGE 48



High-Purity Thorium

This high-purity crystal bar thorium contains the following impurities: oxygen less than 50 PPM, nitrogen less than 20 PPM, and carbon less than 40 PPM. Most metals below 2 PPM are not detectable; the exceptions being aluminum less than 20 PPM, iron approximately 30 PPM, and copper less than 20 PPM. Orders for quantities up to 10 lbs. are being accepted from laboratories interested in atomic power programs. Metal Hydrides Incorporated, Beverly, Massachusetts.

FOR MORE DATA CIRCLE 54 ON PAGE 48

FACE TO FACE

CONTINUED FROM P. 18

But I say that this is a symptom of something that is more deep-rooted.

Are you saying that even if there were enough science teachers, we would still face many problems?

Yes, I say that these are not the causes. They are associated phenomena. They are the result of the same thing that has produced a lack of interest in scientific study. What I have in mind is this, that there has been a definite change in the temper of society and in the public attitude toward science. There was a time when science was considered to be the potential saviour of mankind. In earlier centuries, during the Middle Ages, which have been referred to as the Age of Faith, there was a belief that the problems of the human race could be solved through religion. But man lost faith in faith and for a whole variety of reasons he turned to explore the world around him. Galileo was not interested in applied science, he was just curious—he wanted to know. It's true that in the course of his studies he got interested in why a pump wouldn't pump water more than 34 feet, but he was not really interested in making pumps work better.

And as the men with real curiosity continued to probe and explore, they made it possible for the man of application to come on the scene and put these things to work for us. It must have been a real thrill that ran through the human race when they discovered that knowledge could be applied that way, systematically, so that overnight we seemed to be doubling our control over our environment. It was logical on the basis of that unfolding experience in the 17th and 18th centuries for man to come to the conclusion that if only he could push this process far enough, he would solve all the problems that made life so difficult. It's true he did solve many. He made it possible to stave off epidemics, made it possible to increase the amount of food, raise the standard of living, but at the same time, the multiplication of our scientific knowledge and its translation into applied devices led man to create for himself a kind of impasse that we are living through in its most acute form in our century and it is inevitable, it seems to me, that man should feel that science which was once going to provide all the answers has only succeeded now in creating new, unanswerable problems, problems that are unanswerable by the scientists themselves.

Now when that kind of change takes place, men do not consciously turn away from science any more than the mass of people consciously articulated a departure from the tenets of the Middle Ages. Such a change becomes visible in the fact that you get people shifting their activity. Now this happens, I believe, on the unconscious level. The culture begins to change. The people are not aware of it. The sociologist speaks of cultural lag. We're behind the realities in terms of assessing what place we want for ourselves in our society. In this respect, I think the Age of Science is coming to a close. Now, I don't mean that science disappears, no more than religion disappeared at the time when the church was the dominant influence in Europe. It was the dominant influence because that was the focal point in society to which people aspired. The young man, even though born into the peasant class, felt that he could ultimately rise to be Pope if he went into the Church. When the change came, the Church's temporal power was lost—that doesn't mean that the spiritual power disappeared but the attitude of society began to change and you began to get a diversion of the direction in which young people looked as they mapped out what they wanted to do with their lives. Now, I don't know what is going to succeed the Age of Science, I don't think science will disappear—I think that what you will get is some kind of society that will evolve out of it, retaining many of the aspects of science. But I think that something new will come. But in this transition period we find the falling off of the appeal of science to youth.

Since Russia in general seems to be lagging behind the West culturally, will they therefore have the advantage of continued faith in science?

That's frightening! If that happens, it can be a terrible thing. Because they lag culturally behind us they may yet be dominant in science. They are using all the power of the State to force young people into science.

So that in 20 years they might have an even greater advantage than they appear to be gaining now?

Yes! But I'm not a pessimist. I think other factors come into play. Now we're going beyond the confines of just specific professional interest, beyond physical science. We have come to believe that the individual human being is a completely malleable piece of clay. That if our behavioral sciences were advanced far enough, we would know how to control the individual and shape him to our purposes. I say we are beyond the area of physical science now. Certainly the events in Hungary have demonstrated you can bring to bear all the knowledge that you have, all the phychological knowledge, and all the sociological knowledge, through the fact that a totalitarian regime controls all the instruments of education and propaganda. Only one message reaches the young people—and yet there has been a mighty uprising. There is something inherent inside the individual which cannot be touched from the outside. You just can't educate or condition out of the human being the desire for freedom. I think that's the answer, the evidence of Hungary.

I was thinking the other day of that most horrible aspect of George Orwell's "1984"—the last sentence of the novel spoken by—what's the name of the protagonist, Winston, I think is his name. He's been opposed to the regime, you remember. They finally get hold of him and bring him into the torture chamber and they break him, and finally he's released. After Winston has gone through all the agony and the torture, he goes back to life under the totalitarian regime. And the last sentence of the book says, "And now, he loved Big Brother." But the Hungarians show that that final horror the totalitarians can't achieve, and the individual will just not love "Big Brother" because there is something inside himself. No matter what you do externally to him, that change they can't effect. And so I believe that a lot of these young people who are being dragooned into science by the Russian regime, are not going to be completely shaped by the regime. The very fact of making scientists out of them has to leave to them some initiative because you can't have a scientific mind without the kind of curiosity that says, "I can explore and find out things for myself." And just as soon as a totalitarian regime allows any area that is not absolutely controlled by the State, it's not totalitarian—in truth, I don't believe you can have a totalitarian, really total regime, and the Russians are discovering that. They tried to relax after the Stalin terror, and the only consequence of the relaxation was that Poland and Hungary insisted on freedom. And it's a heartening thing that they did. So I don't believe that it is fatal if the Russians will be outdistancing us in science. They will be creating an internal problem at the same time. They

(Continued on page 32)

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are creating within the Soviet society a group that will finally burst out against the regime as the Hungarians did.

How about the success with which we will get youngsters to go into science? What techniques do you think will overcome this general reaction against science, will motivate more young people to go into science? Will there be anything that will be successful?

Well, I think that you are going to have to do a lot of things. You will have to attack the symptoms, you're not going to be able to hit directly at the causes, but you're going to have to provide more government funds—there's no other answer—to create the facilities for education. You will have to start in the public schools a program aimed at presenting science as something other than the pursuit of atomic and hydrogen bombs. That isn't a difficult job to do. The fact is, of course, that the headlines have been taken by the atomic and hydrogen bombs. We need a systematic program—and there are many that are functioning—the only difficulty is that they don't have enough resources.

Can't it be delegated to industry?

No, industry cannot do it alone. Owing to the whole vast educational system which is beyond the reach of industry—industry can cooperate, industry must—industry can provide many of the tools that are needed to do the educational job.

And industry may be creating greater problems for itself by hiring teachers away to work in applied science?

Well, I think we are also suffering from the fact that industry cannot afford to raid the schools! Industry must recognize that it's got to take the long run too.

How do you feel about the Sarnoff plan to have engineers and industrial scientists go back into the schools on a sabbatical basis?

Gen. Sarnoff really came up with a valuable contribution in presenting his plan, because it certainly has the effect of underlining the responsibility of businessmen in meeting the problem. That's very important, this assumption of responsibility by businessmen. A group of us were discussing the plan at lunch—some of the officers of the Research Institute, the dean of one of the leading schools of commerce in a university here in New York, and several others. When the dean heard our approval of the Sarnoff plan, he slyly put it to us, "How about our borrowing some of your men for a semester or two?" He had us! We said we couldn't afford to part with any of our men. Theoretically, we had all agreed the Sarnoff plan was right, but when it got down to making the sacrifice of parting with some of the men, even on a part-time basis, the answer was "No"!

An attorney who once specialized in labor law, Mr. Levenstein is responsible for the information and advice offered by RIA to 50,000 American executives. Tested human relation techniques are used to help solve supervisory problems and make management more effective. The author of Labor Today and Tomorrow, (Alfred Knopf) *he has also written many articles and radio and television scripts.*

How do you feel about other motivational techniques, fringe benefits, moving expenses and stuff like this in addition to money? Some recent surveys show that money is not the prime motivating force among engineers and scientists.

Well, I think you've got to qualify that. If the pay scale and the benefits are few, you will lose out. But the pay scale and the benefits can be good, and you will still not get motivated people. I don't know a simple way to express it. We do know that poor monetary reward or a failure to give adequate economic reward, makes it impossible to motivate people. But we also know that you can give very good economic reward and still leave people unmotivated, because what's involved is not merely a question of the man's gaining satisfactions outside of the job which is what these rewards provide. The economic reward gives man the satisfaction off the job, he can buy himself a better home to enjoy after work hours, he can dress his wife up in nicer clothing thus stimulating himself to greater enjoyment. All these are possible but they are outside those hours that the man spends on the job and you need motivations for stimulating satisfaction and effort during the working day. But in the absence of these monetary and economic rewards, nothing that you do inside the plant is going to be satisfactory. You can't substitute human relations for a decent pay envelope, but you can give a decent pay envelope and still have unmotivated men on the job, because within the four walls of the work site, the men are not getting satisfaction out of what they're doing. In other words, you still have the problem of *building a relationship between the man and the work he performs.* That calls for a continuing, unending kind of communication between the company and its people, constantly giving them the bigger view.

This makes the job of management just that much more difficult.

That's right! It puts increased obligation on them.

And apparently these obligations are going to continue to increase. Are there any gimmicks for avoiding good management?

No! That's part of the problem—the time that management wastes in hunting the gimmicks.

By the way, what do we mean by gimmicks?

Well, a gimmick is a device that offers the form without the substance. One gimmick might be a company picnic for its people. Of itself, the picnic is meaningless. If, however, that form is filled with real substance that conveys the reality of the company's interest in the welfare of its people, then the picnic can have meaning. But if it is merely a device because somebody says it is a good idea to have a picnic, it won't do the trick. What's involved is this. Essentially, it's a problem of communication. Communication always requires two things. It involves, first of all, a method of transmission but it must also involve a meaningful message that is sent along that transmitting device. Now, many companies spend a lot of money setting up wonderful transmission instruments, spend a lot of money on a house organ. But what do they say in the house organ? "An acre of engineers?"

As the human being is constituted, communication does depend on the use of symbols. Words, themselves, are symbols. We know many semantic problems arise because of the inefficiency of words when it comes to carrying messages. But that's all we've got. We've got to use these symbols. There's no way of communicating without them. One of the difficulties is we begin to mistake the symbol for the substance and we then go through ritual behavior as a result. By ritual behavior, I mean the kind of thing we do because it once had meaning, but that has now been reduced to mere habit, so that we're no longer aware of its meaning or purpose. We think it's enough to mouth the words, but the words are not the important things, the important thing is the message that the words are supposed to carry and if that's lacking, using the words is not going to do any good.

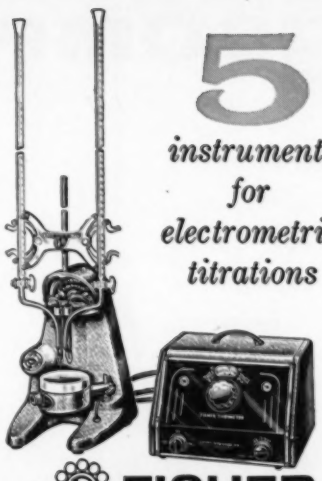
You take one of the problems that baffles ritualistic management, they can't understand why it is that Joe Doakes who is very polite, says all the right things, yet is disliked by the people who work for him. While someone else who uses every four-letter word that has ever been contrived, and who seemingly is abusing his people every time he opens his mouth, is well liked by his people. Well, the explanation is simple. The important thing is not the polite form or the impolite word, it's the message that the individual conveys, and one fellow can say to another, "Now listen here, you———, I'm going to tell you something!" But the fellow who hears it, recognizes that he's really saying, "Look, I'll lend a helping hand to you".

You've got to go beyond the symbols; the symbols are the gimmicks. To a very large extent, it's true that in human relations, you can't influence someone else until you've first influenced yourself. Your starting point has to be your own attitude, and there's nothing fancy about that, yet it is complicated. The impact that a company has on its employees is in direct proportion to the employees' perception of the company's attitude. When the attitude is on a high level of real concern for its people, and the company does what it takes to make the people see the reality of its attitude, then the result is good.

Foreign Recruiting

Many American companies are now starting to recruit foreign engineers and scientists, not in enormous numbers, but they are starting to bring them over in greater and greater numbers. Do you think that they will have other motivational problems with these men than they have with their own employees?

I should certainly think that they would prepare themselves for problems of adjustments among the men. The first problem that occurs is generally the relationship of the new man to the company. In the case you mention, the problem may well be the relationship of the new man to his colleagues. I think you are bound to have some problems there, problems of communication among them. Some of the studies that have been conducted on turnover reveal that the real difficulty is often not with the individual's relationship to higher management, but it's his relationship to his fellow employee. If he likes the people around him, he's not going to be inclined to look for another job. Much more attention has to be given to the relationships among the professional men themselves, providing opportunities for them to communicate with each other, to cooperate with each other. I think that you do face a barrier when you bring in another ethnic group. I see no reason to anticipate that it would be a problem of major dimension, certainly not if the company undertakes to encourage healthy relationships. END



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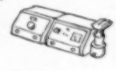

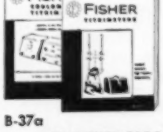

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CIRCLE 16 ON PAGE 48

COMPONENTS

Zip-Up Harness

The high costs of preparing harnessed wiring for electrical and electronic apparatus can be reduced by using this unusual zipper equipped tubing. The zipper pull-tab used to close Zippertubing is detachable, and the tubing may be "unzipped" and re-used, or permanently sealed with a sealer provided by the manufacturer. When sealed, Zippertubing will withstand a linear strength-test of 30 lbs per inch. Available in nine colors, including black and clear plastic, Zippertubing is made of polyvinylchloride plastics which meet military specifications MIL-I-631B and MIL-I-7444A, for use in aircraft and other types of military wiring. W. A. Plummer Mfg. Co., 752 S. San Pedro St., Los Angeles, Calif.

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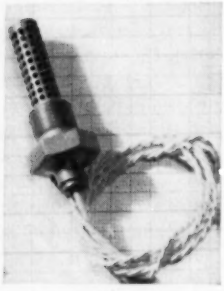

Temperature Transducers

Designed for telemetering and other applications requiring high signal levels, these resistance-type temperature transducers give outputs up to 5 volts without amplification! Models are available in a wide variety of physical configurations for measurement of surface, fluid, and air temperatures. Standard units cover —320°F to +500°F range with +2% linearity. Arnoux Corp., 11924 West Washington Blvd., Los Angeles 66, Calif.

FOR MORE DATA CIRCLE 21 ON PAGE 48

Tiny Accelerometer

Weighing only 3 oz., this accelerometer can be used in instrumentation and control systems for missiles and target drones. The series LA03-0200 withstands vibration from 0 to 2000 cps to 10g. It is shock resistant to 40g. Linearity is 0.5 to 1.5%. Humphrey, Inc., 2805 Canon St., San Diego 6, Calif.

FOR MORE DATA CIRCLE 23 ON PAGE 48

Power Pickup

This power pickup serves as a self generating power source for operating directly over and under speed controls or warning devices. It provides sufficient power to operate low voltage electrical devices without the use of an amplifier. The power output is approximately 10 times that of this firm's conventional Model 3010-A, with an optimum load of 1000 ohms and 750mh average pickup inductance. At actuating surface speeds of 250 or more inches per second, the 3040 provides sufficient power to operate relays having 100mw sensitivity. Electro Products Laboratories, 4501 Ravenswood Avenue, Chicago 40, Ill.

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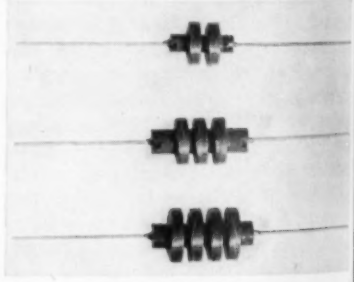

High Q in Small Size

This fine series of r-f chokes includes solenoids on phenolic and powdered-iron forms and pie-wound coils on ferrite cores, phenolic forms, and powdered-iron forms, all with pigtail leads. Pie-wound coils on ceramic forms have soldering terminals secured to the form. All units have finish conforming to MIL-V-173A; special finishes can be supplied. Inductance ratings are from 1.1μh and up. Current ratings are from 50ma to 2800ma. Waters Manufacturing, Inc., P.O. Box 368, South Sudbury, Mass.

FOR MORE DATA CIRCLE 24 ON PAGE 48

Energy Cartridge

These pre-assembled stacks of multiple spring washers offer many design possibilities. Examples include: as a shock absorber; in machinery such as impact presses; to exert force at a low rate, such as in clutches for automotive drives; and to maintain reasonably constant pressure in spite of expansion due to temperature variations. They are best used wherever a high load is required within a small head space. The spring washers are held together by pins or rivets passing through the washers at or near their neutral axis. Associated Spring Corp., Bristol, Conn.

FOR MORE DATA CIRCLE 25 ON PAGE 48

U-H-F Twin Tetrode

The Type 6907 twin tetrode is designed for Class C amplifier service in mobile and airborne communications equipment. The new tube will deliver up to 25w output at 462Mc in continuous operation. It is rated as an amplifier or frequency tripler up to 600Mc and will deliver power up to 1200Mc. It is also ideal for the 225-400Mc military bands, where it will deliver 20w within its continuous operating ratings. At this operation level it does not require air cooling or special sockets, thus keeping costs at a minimum. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L.I., N.Y.

FOR MORE DATA CIRCLE 27 ON PAGE 48

High-Altitude Valves

This solenoid operated, three-way, two-position hydraulic selector valve has been continuously operated at 50,000' altitude without deterioration of insulation. It works at pressures to 3000psi, is light in weight and has no moving seals. Gladden Products Corp., 635 W. Colorado, Glendale 4, Calif.

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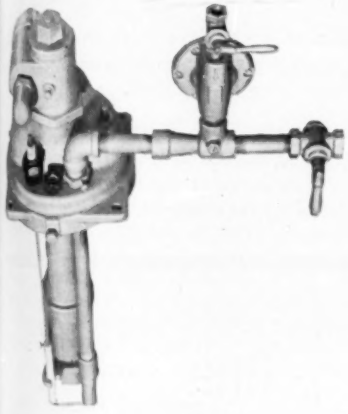

Radiant Tube Burner

These radiant tube burners for industrial heating can be mounted directly in either metal or ceramic radiant tubes. A choice of mounting, air and gas regulation and ignition features adds to the flexibility of the new burners. Three types of ignition are offered—gas pilot, spark or pilot-spark combinations. Eclipse Fuel Engineering Co., Rockford, Ill.

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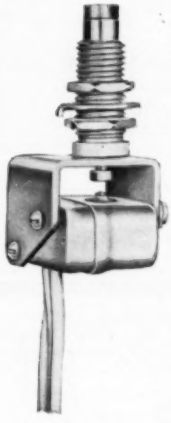

Sealed Switch

Primarily for use on aircraft and missile applications, this hermetically sealed switch will operate under the most trying environmental extremes. It comes complete with actuator and has passed 50g shock tests. The switch is bonded to the switchcover and will withstand 100-psi pressure differential inside to outside without rupture or leak. Haydon Switch Inc., Waterbury, Conn.

FOR MORE DATA CIRCLE 28 ON PAGE 48

Synchros

These three-minute Size 23 Synchros offer high accuracy in control and data transmission synchros. In many instances they eliminate the need for two-speed synchro systems—thereby reducing cost, and effecting appreciable economies in weight, size, complexity and gearing problems. Matched pairs of synchros are available to provide even greater system accuracy. Norden-Ketay Corp., Commerce Road, Stamford, Conn.

FOR MORE DATA CIRCLE 30 ON PAGE 48

Vacuum-Pressure Control

Automatic vacuum and pressure control has been combined in one instrument. The Cartesian Manostat No. 10 is of value to the chemical industry for distillation, evaporation, and reaction vessels; to instrument makers, for high precision pressure calibrations, constant pressure or vacuum chambers, and for precise flow control in gaseous systems; and in aviation, for calibration of precision instruments. It contains a permanent, accurate memory system. Once the vacuum or pressure is set on the Manostat, the setting will not be disturbed even if the system is closed down and later reopened. Manostat Corp., 20-26 North Moore St., New York 13, N.Y.

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ADMINISTRATIVE ASSISTANTS

(Continued from page 15)

dinate managers are forced to report through the assistant. He makes decisions in the boss' name, assigns work, and gives orders.

While this relationship works in a few cases, it frequently clogs communications in the department. The boss loses touch. Communications, both up and down, have a way of being channeled through the assistant. Reports get slanted. Statements get altered. And a great deal of fumbling, delay, and misunderstanding results.

3. Make "Package" Assignments

Fairly early an administrative assistant learns that he must mesh his efforts with those of his boss, subordinating his preferences and even altering his work habits to match those of his principal. He takes this for granted as a natural corollary of their close relationship. Few executives would like to admit that they take advantage of this attitude. Yet a great number do. Using assistant as tools for the boss' personal aggrandizement is a common practice in many companies.

A good indication of whether the manager is doing this lies in the way he makes assignments. Does he assign an entire package? Does he explain fully the purpose of the assignment and the objective to be attained? Or does he assign a job by halves?

In every job there are tedious and boring parts, such as library search, collating, and tabulating. A manager who requires his assistant to do the distasteful preparatory parts, and retains for himself those last rewarding steps of interpreting the data and affixing the signature is creating an angry, balky assistant. If, however, he makes each assignment a complete package, he is well on his way to creating a productive, fruitful collaboration.

4. Define Your Assistant's Province

Nothing is more unsettling to both the administrative assistant and the line manager than uncertainty and doubt about the assistant's duties and responsibilities. To the line manager, such doubts bring about confusion, delay, and duplication. In the end it becomes almost impossible to tell who's in charge of the operation.

On the assistant's side, it causes anxiety over whether he's stepping on someone's toes, charges of "meddling", and serious insecurity about his job. The alert executive can avoid these occurrences by defining his administrative assistant's role clearly beforehand.

In outlining the assistant's bailiwick, it usually pays to make his role as broad as possible, and at the same time limit it to purely *service* functions. Also, responsibilities should be specific. A plan of organization which accomplishes these aims is found in the chief-of-staff concept used by the R/D department of the Sylvania Electric Products Co. (see Fig. 4 on p. 14). This plan has three characteristics.

- The administrative assistant is off the main line of command, and does not block the line managers.
- He has a specific area of staff responsibilities, with freedom to organize, plan and control the work in his province, as well as to produce completed staff work.
- The functions over which he is responsible are spelled out in detail, so that there can be no confusion.

An assistant who has not been given a specific area to govern becomes insecure and ineffective. But with clear duties he can perform a valuable service.

5. Respect The Line Engineer's Province

One of the chief advantages of an administrative assistant is that he's not confined to any one part of the R/D organization. He can move at will from department to department. This mobility puts him in a good position to coordinate projects and develop procedures.

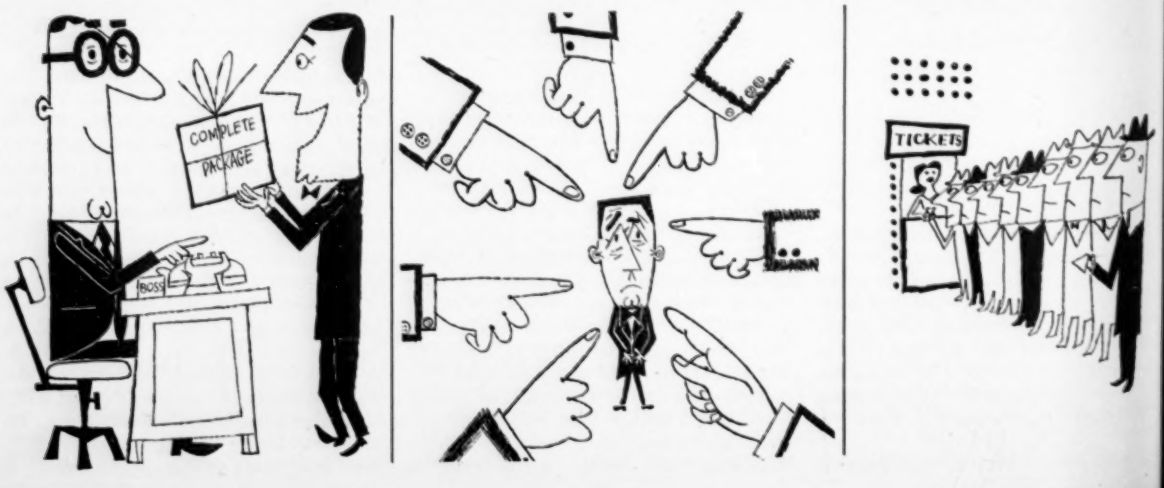
But it also has an inherent danger: the temptation to encroach on the line engineer's province.

Even after the assistant's place in the organization has been clarified, there is always a temptation to draft the assistant for special jobs in the line. For example, an administrative assistant in a chemical company, an expert in plastics, may be sent to do a special job in the plastics R/D division, much to the discomfiture of the associate director in charge of plastics research and development.

This type of encroaching fosters resentment which runs deep in the line organization and strongly affects the attitudes of the members of the staff.

6. Avoid Making Your Assistant Heir-Apparent

Unless you intend to have your administrative assistant take over when you retire or transfer, you should try to avoid the appearance of favoring him over line man-



agers. Several aspects of the administrative assistant's post have a way of lending support to the view that you may have tapped him as your successor.

For one thing, the administrative assistant appears next to you on the company's organization chart. Also, he handles the same type of duties as you do. And most significant, he takes charge of the department when you are away.

Nothing can be done about the first two implications. But, it's possible to prevent the third by turning the department over to your line managers on a rotating basis when you leave the office for any length of time.

7. Move Ahead on Your Own

After you have established your administrative assistant, given him duties matching his abilities, given him "package" assignments, and clearly defined his province, you may feel that the natural thing to do next is relax.

A much better step at this point is to use your free time to get back to fundamentals. Perhaps the most valuable move you can make is to reappraise your department—with a view toward charting a course for the future. It is not necessary to start calling meetings right away in order to discuss these matters. Probably the most profitable reassessment will occur alone, or in private conversations with your subordinate managers.

Certainly, the R/D director should not doff his administrative hat simply because he has a competent assistant. Yet this will happen if he doesn't plan ahead.

These Are The Ways

And this brings us back to where we started. A successful boss–assistant collaboration depends on how the boss uses his aide. Essentially, a good relationship rests on the boss having equal respect for his assistant and his line managers. END

Why Engineers Join Unions

In 1952 a number of engineering societies amalgamated to form the Engineers and Scientists of America. Since that time the ESA has developed into a trade union of 30,000 members, the National Industrial Conference Board revealed in a study just issued. Besides these 30,000 union members, many more engineers are associated with the various affiliates of the AFL-CIO. For example, the American Federation of Technical Engineers alone claims 15,000 members; and many others have joined the AFL-CIO locals for their industries.

Why has this drift toward unionization taken place in a segment of industry which has historically been professional? The thousands of union members quizzed in the Conference Board's poll gave a variety of answers.

Collective Bargaining

For one thing, unionization enables engineers to get the following guarantees into their contracts:

1) That the salaries of long-time employees will stay well ahead of the starting salaries of new engineers.
2) That engineers will enjoy extra pay for overtime.
3) That merit rating will govern promotions and dismissals.
4) That engineers in the field will receive travel allowances and relocation pay.
5) And finally, that engineering inventions will be covered by patent protection.

The Other Side of the Fence

The attitude of engineers about their pay offers an unusual angle. Hardly any engineers claimed that their pay was inadequate *per se*, but a great number felt that their pay was inadequate *by comparison with* some other group. Many felt that they were making too little by comparison with production workers. Others felt that they were making too little by comparison with newly-hired engineers. and engineers in all industries said that their company was paying too little by comparison with what other firms are offering.

Standard Replaceable Parts?

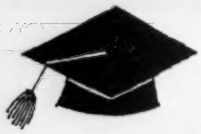
A second grievance was the engineers' feeling that they are being treated *en masse*, never as individuals. They are recruited by the hundreds and, because many government contracts are cancelled suddenly, laid-off by the hundreds. All this does not add to the individual's feeling of importance.

Policies and Practices

Engineers in the NICB survey had some unpleasant remarks about their companies' policies and personnel practices. They are being assigned jobs which do not require a high degree of training or intelligence, many said. And many claimed no recognition for the reports and work they performed.

Some Just Believe in Unions

In case you feel that this is a large dose of grievances, the NICB offers the following consolation: A great many engineers hold union cards simply because they see no harm in it.



Did your Education educate you?

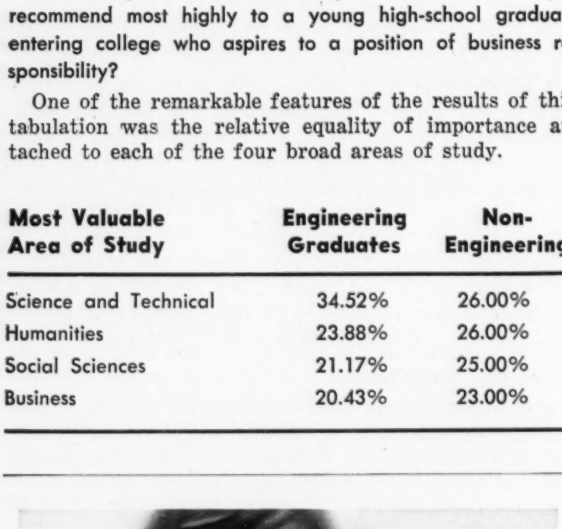
(Continued from page 29.)

There was great enthusiasm in many of the replies for the liberal-arts curriculum for personal satisfaction outside of the business office. Many respondents indicated that their enjoyment of life was directly traceable to a broad background of interest generated by the program of study in the liberal-arts college.

What specific areas of study or courses would you recommend most highly to a young high-school graduate entering college who aspires to a position of business responsibility?

One of the remarkable features of the results of this tabulation was the relative equality of importance attached to each of the four broad areas of study.

Most Valuable Area of Study	Engineering Graduates	Non-Engineering
Science and Technical	34.52%	26.00%
Humanities	23.88%	26.00%
Social Sciences	21.17%	25.00%
Business	20.43%	23.00%



Mighty Mite

This tiny permanent magnet supporting 215 times its own weight is part of the unique electrical motor that drives the new Hamilton electric watch. Weighing only 0.0056 oz, the magnet is 77% platinum and 23% cobalt. The watch runs for a year on the energy in a battery the size of a shirt button. Important advances in instrumentation could result from the techniques developed over the past 10 years by Hamilton in engineering the new watch.

The obvious inference is that the composite General Electric college graduate is specifically in favor of a broad program of study encompassing some work in each of the above categories. The average pattern of response for Non-engineering Graduates (allowing each person three choices of courses or subject-matter areas) was (1) English communication and expression, (2) Economics, and (3) Mathematics, Engineering, or Business.

Engineers, as might be expected, placed heavy emphasis upon their specialty and ranked Engineering as the number one course, with English, Economics, Business, and Mathematics respectively following in line. Several expressed caution, however, and said that engineering was their first choice *only* in the event that the student planned to enter a business similar to General Electric. Otherwise they would have placed English in first position.

Are college values more lasting in influence because of subject matter or teaching personality?

Engineering graduates were apparently more influenced by subject matter than by teaching personality. Every sub-group with the exception of Chemical Engineers on non-technical jobs placed subject matter first. On the average, 48.84 percent of all engineers rated subject matter first; 45.28 percent ranked teaching personalities as more important; and 5.87 percent reported either "both" or "undecided."

If you were starting life again, would you attend the same college and take the same program of study?

Three out of four Non-engineering Graduates would return to the same college if they had the choice again. The greatest degree of dissatisfaction among the remaining quarter was found among those who had attended teachers colleges and received a degree in Education. Generally, they had entered these schools with a professional desire to teach and now, employed in industry, they believe a broader education would have been of more general and lasting value.

Engineering Graduates as a group were even more satisfied with the educational institutions of their choosing. If the opportunity of choice were again available 85 percent would go to the same institution. Since a career in engineering requires considerable planning, it would appear that more care had gone into the selection of the college, thus creating an atmosphere of satisfaction.

Comments Concerning the Liberal Arts

The prime purpose of undergraduate college education, according to many respondents, is not the acquisition of specialized information and operational techniques. Rather, it was volunteered time and again that the power to think and to analyze a wide range of problems successfully is the true goal of college education. Even if some consideration is given to the technical aspects of education, failure to produce an individual with these abilities is in essence a failure of the college program itself. The "whole man" concept seems quite strong in the thoughts of this group of employees.

The importance of concentrated study in the areas of English and Mathematics is also deserving of a final note. The fact that both fields have become indispensable to human expression and understanding is accepted by this survey group. Heavy concentration upon both areas of study was deemed essential in the shaping of tool courses for successful living.

Many comments had it that the broad background offered by the liberal-arts curriculum can be tailored to a highly successful career in industry, particularly on the managerial or professional level.

• • •

Comment

GE's Educational Relations section has carefully delineated and conservatively interpreted its poll. It will be of interest to engineers and of value to educators. Especially if read with the following reservations.

The poll has the interviewed person distinguishing in himself between the professional function and the whole man. And so its first limitation is the assumption that this distinction is possible; and, if possible, clear. A correlative limitation is the assumption that each person interviewed (or anyone, for that matter) can attribute to these artificial parts proper credit for the contribution each makes to his whole performance.

The difficulties are immediately apparent. The engineer may assert that his study of a foreign language has contributed only to his spare-time pleasure and little or not at all to his proficiency as a technician. But he cannot say that studying a foreign language has not made him more sensitive to his own language—its idiom, its structure, its limitations, and attributes. If study of a foreign language has done that, it has made him more proficient in communication. Thus he can read more effectively, write more effectively, and speak more effectively. He can, indeed, think more effectively. The attributes of his non-career or pre-career pursuits, in this way, directly influence his job performance. And the distinction he made earlier between his two parts is perhaps less valid.

The argument holds as well for mathematics (in the case of the non-engineer), and for much of the humanities (for engineer and non-engineer alike).

A further consideration with which these results should be read is the *anatomy* of the courses listed. The course referred to cannot be the same in the minds of all the persons interviewed. "Philosophy" might suggest a barren survey course to one person, medieval theology to another, Platonic dialectic to a third, huge lecture classes to some, small seminar groups to others. Those who went through a survey course, that was no more than an agglomeration of facts divorced from the stream of thought and the context of human concerns that produced them, would understandably hold the subject to be of small or no value. But others who may have taken the same subjects probably consider them of great value if they were presented with some depth and breadth —not merely as collections of facts but as the objects and stimulants of original thought by the student. Thus the largely unique experience of each person questioned determines his answer. And since the experience is not the same for all, the validity of conclusions based upon the statistical sum of 13,000 opinions is seriously compromised.

Certain subjects should not be understood as being truly representative of all engineering and non-engineering opinion. It shouldn't because the people interviewed were all of a category—they were all involved in an essentially technical enterprise (i.e. General Electric). That common orientation represents a fundamental and prior selection of the sampling; and so the opinions expressed could not be expected to differ widely between engineering and non-engineering respondents.

Despite these few reservations, GE's survey can be read with interest and enlightenment.—SANDEK.

Copies of What They Think of Their Higher Education *will be available in mid-January from the General Electric Co., 570 Lexington Ave., New York, N.Y. Attention: Miss Jeanne Pierce.*

Bearded Metals

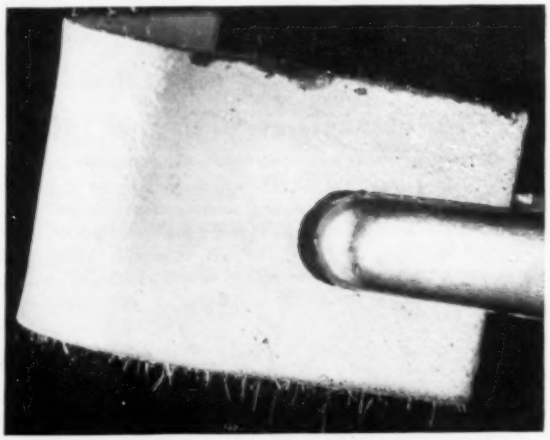
Deep in the maze of Bell Telephone's long-distance circuitry, a filter component strangled in its own whiskers. A post mortem performed at Bell's Murray Hill Labs revealed that a zinc-coated bracket had grown tiny conductive whiskers — and these had grounded a nearby capacitor.

The obituary is a happy one, for the event started a series of experiments that have gone on for five years. Results: a better understanding of the materials of electric components—the problems involved in their use, and the solutions.

Bell discovered that zinc, tin and cadmium, used to plate telephone apparatus, were among the whisker-growing metals. Their use has been discontinued in critical small-space applications. Gold, it seems, never develops the whisker propensity, and so it now replaces the other three metals.

Though the whiskers are microscopic, the phenomenon is particularly important in tiny electronic parts like transistors, where the minute growths could cause short circuits between closely spaced metal surfaces.

Bell is still researching whisker growth and composition. They are examining more than 3000 samples for hirsute fertility. One possible outcome: metals superior in strength and durability to any we know today—the whiskers are far stronger than the metals from which they sprout.—LS



The whiskers on this half-inch wide tin-plated sample represent a three-year growth. Single crystals of tin, they range up to 3/16-inch long and 80 millionths-inch in diameter. Growth of the whiskers can be accelerated by neutron bombardment.

TECHNICAL MANAGEMENT *(Cont. from p. 3)*

I think you can change people, but first there must be a desire on the part of the person to change; and I have found that people do not take readily to adapting their work patterns to accommodate an activity that they consider as a service to them.

Finally, *how does the library fulfill its role of a cross-fertilizer of ideas?* I look on the library as a place where communication can be very effectively promoted. If the librarian knows the subjects your engineers are interested in, very valuable material can be routed to them.

The library should also make it a point to issue information on what material it has, how it can serve you, what areas are covered in intercompany and interlibrary loans, translation and microfilming services, etc.

All these points are important to consider in the library's ability to serve you.

This Month's Problem

Now I am going to pose a problem, and I would like to have your discussion on it. I would also be interested in hearing what librarians might have to say about this problem.

You are a technical manager. A while back, one of your engineers asked the library for a particular article to read and study. The library got the article by borrowing it from another library. The engineer kept the book for the full loan time. You find all this out when the librarian comes to tell you that the engineer has been very rude to her. He found that she had visited his office when he was out, picked up the book, and reclaimed it before he was finished with it. The librarian claims to have sent several notices to him without reply; so she picked the book up. Her complaint is that the workers should be more understanding. This shouldn't be allowed to happen again. Obviously, you are expected to do something about it. Do you call in Engineer Jones and lay down the law? Do you tell the librarian to take care of these things and not bother you? Is it the librarian's job to straighten these problems out? Do you pass the problem down to the next man in the chain of command? Do you give it to a staff man to iron out? Should they be brought together for a conference? Do you let it die, hoping it will not come up again? How could the incident have been avoided? Let's hear from you.

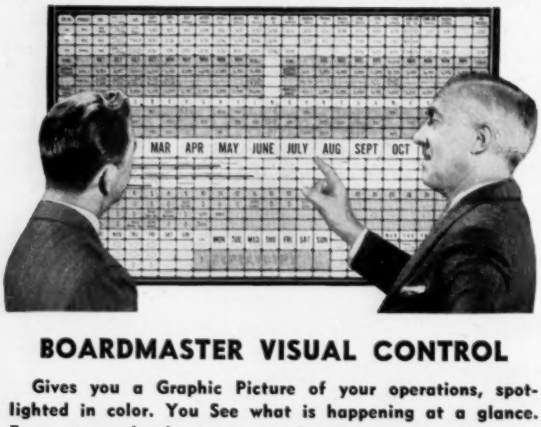
Discussion on "The Human Dynamo"

In the October issue as you will remember, I reproduced a letter I received from an engineer who laments the fact that because he is too fast with the delivery of new ideas, no organization he has ever worked for is fast enough to keep up with him, and he can't get things done as he wants to. Well, this letter stirred up a flurry of correspondence. We received considerably divergent points of view. It is interesting that those who are "agin" the man have written longer letters and have been much more explicit than those who are "for" him. I'll try to pick and choose the essence of each argument.

Henry W. Kaufmann writes: "Your fireball forgets that these days unevaluated ideas are fairly cheap. The problem of most managements is to concentrate available capital on the best ideas. Most organizations . . . do not want to go into competition with the shoestring operator or take on projects which can be executed by one fireball and three or four engineers, unless the project fits in very well with either their manufacturing or marketing capabilities. The fireball is unwilling to fit his output to such specifications." Mr. Kaufman points out that a large organization might find a use for this human dynamo as an expediter or to complete projects before their deadlines, or a company committed to going into new fields on its own might have the free booting energy to satisfy this engineer. "He fits only into a changing condition," Mr. Kaufman points out. "As soon as schedules or budgets mean anything—as soon as the Comptroller is an officer of the organization rather than a part of the boss' psyche — Fireball will be too expensive a luxury . . . . If he isn't needed for a command o-type operation as suggested above, he can be built up to the point where a competitor will steal him away; or he can be painted with aluminum enamel and sold to Madison Avenue where he really belongs."

An engineer in his sixties, author of many papers and holder of many patents (he asks that his name be withheld) has the following comments to make: "Whereas hard work and diligence are required to achieve success in the field of development and research, and certainly hard work and diligence will reduce developmental time; nevertheless, it is my feeling that the human dynamo described in the letter is probably immature. He confuses activity for progress. Furthermore, he indicates that he considers people as non-essential. This completely disregards all consideration of team play and human motivation.

How To Get Things Done



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FOR MORE INFORMATION CIRCLE 34 ON PAGE 48

Mr. C. W. MacMillan writes that if this person has consistently really good ideas . . . original and workable ones . . . he is a rare exception and should be in business for himself. If he isn't interested in wealth, then he belongs in an organization which follows a "blitz" development policy. "Competition in industry makes this type of contributor very valuable, even if he is non-conforming." He points out that high rates of speed and short life go hand in hand and that the turnover of the "eager beaver" is very high. His advice is for him to go out and learn to play golf!

Another correspondent who prefers to remain anonymous writes that he is sympathetic. He has gone through this stage and has seen a friend go through it. Now, about 15 years later, he has resigned himself to a more philosophical approach to life. He doubts if a man working day and night is fair to the organization, to his fellow workers, or to himself. Although condemning managements that insist on extreme conformity, he writes, ". . . the creative individualist also must do his part toward meeting the other types part way. He must realize that the drones do not like being hammered into submission any more than he does." What the writer recommends is a face-to-face talk with some older and more experienced man who understands him and whom he respects.

Also another voice of experience, who prefers not to have his name used but who has an impressive biography in "Who's Who in Engineering," says:

"In the concluding paragraphs of the October RESEARCH & ENGINEERING article on pages 3 & 4 you set out the problems and aspirations of a 'human dynamo'—which are fairly familiar problems. In one instance regarding which I believe I have accurate information a very large industrial organization provided a substantial 'grub-stake' for such a man who was on the way to the development of a new and important product—in return for which the company was to receive an agreed share of any resulting patents and earnings. The stake was, I believe, $100,000, and the man had full opportunity to use his idea and energies and business judgment. (With substantial success it may be noted). He would have been a fearful pain in the neck to his boss—had it not been that he was his own boss."

Another letter reads: "If your man is for real, and is not welcomed and made comfortable in a research and development organization, heads need to be examined. Not the head of your correspondent—but that of management. Put him in touch with me."

H. B. Felder of Clark Equipment Company writes that the human dynamo is like any other natural resource; "the dividends go to him who finds it and finds ways of putting it to work." His suggestions on harnessing the dynamo:

"1. Go along with him. The things he resists *are* barriers to enthusiasms and to vigorous or stubborn pursuit of an objective.

"2. He does not lack intelligence, and therefore is amenable to some control by logical argument. An ordered series of questions will force him into a corner, as a man on a chess board. So cornered he will admit the need for keeping better log notes, presenting a progress demonstration to management, calling in second man for safety in night work, etc. "If you can't corner him, trade jobs with him; he's smarter than you are!"

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For temperatures up to 4600° F. Possesses one of the highest melting points of all commercial refractories.

Extreme chemical inertness. Won't erode when melting steel or high temperature alloys . . . won't react when firing titanates or sintering metals . . . won't embrittle platinum.

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FOR MORE INFORMATION CIRCLE 35 ON PAGE 48

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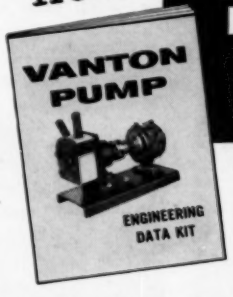

VANTON PUMP eliminates packing problems in handling corrosive or abrasive liquids. Liquid flows in channel between molded plastic body and synthetic liner. Ideal for lab, pilot plant, and full-scale production use. A full-time production tool in the 1/3—20 GPM range.

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Division of Cooper Alloy Corp.

Please send further info. on Vanton pumps.
My pumping problem is:

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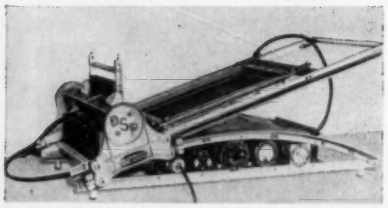
FOR MORE INFORMATION CIRCLE 36 ON PAGE 48

LABORATORY EQUIPMENT



For Prototype Printed Circuits

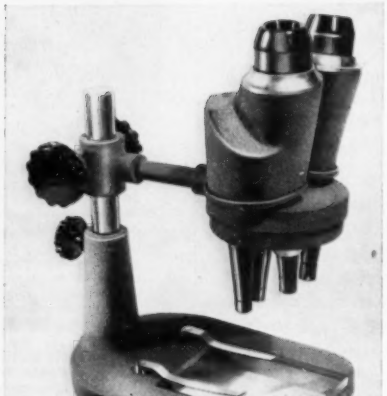
Prototype printed circuits up to 8" x 14" can be made on this Mark III Junior press. The panels come off the press ready for etching in minutes. Back-to-back designs can be registered within 0.007". Dry Screen Process Inc., 1016 Madison Avenue, Pittsburgh 12, Pa.

FOR MORE DATA CIRCLE 38 ON PAGE 48

Double-Duty Device

R/D laboratories vexed by the shortage of technicians will be interested in this combination heater and magnetic stirrer. Hours will be saved in routine stirring, mixing and dissolving. The hotplate and stirrer can also be used independently. Pittsburgh Plant, Fisher Scientific Co., 717 Forbes Street, Pittsburgh 19, Pa.

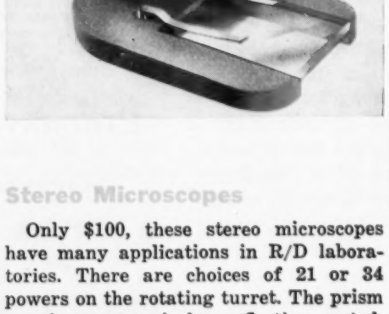
FOR MORE DATA CIRCLE 39 ON PAGE 48



Stereo Microscopes

Only $100, these stereo microscopes have many applications in R/D laboratories. There are choices of 21 or 34 powers on the rotating turret. The prism erecting system is low-reflection coated. Edmund Scientific Co., Barrington 17, New Jersey.

FOR MORE DATA CIRCLE 40 ON PAGE 48



Plastic Sleeves

Chemically inert except to metallic sodium, these sleeves provide vacuum-tight seals between jointed glass without the need for greases. They are made of polytetrafluorethylene film and resist temperatures to 300°C. They are accurately tapered to fit a variety of ground glass cones. Priced from $1.50 to $3.10 each. Arthur F. Smith Company, 311 Alexander Street, Rochester 4, N. Y.

FOR MORE DATA CIRCLE 41 ON PAGE 48

Controls Many Temperatures

The Multi-Point Pyrometer Controller automatically controls the temperatures of up to 10 different laboratory equipments. Many temperature ranges are available between —400°F and +3250°F for all standard thermocouple calibrations—and from —100°F to +1600°F for resistance bulbs. Usual operating speed is three seconds per point, 30 seconds for all 10 points. Thermo Electric Co., Inc., Saddle Brook, N. J.

FOR MORE DATA CIRCLE 42 ON PAGE 48

Low-Cost Shake Tester

For labs without their own vibration testing equipment, the Model 14-28 tester may be the answer to your prayers. It tests prototype designs up to five pounds in weight at frequencies from 10 to 55 cy. Amplitude is infinitely variable up to 0.040". The machine costs less than $300. The Ahrendt Instrument Company, 4910 Calvert Road, College Park, Maryland.

FOR MORE DATA CIRCLE 43 ON PAGE 48

Chiller for Impact Testing

Only two feet high, this low-temperature chilling machine was designed to chill metal specimens for impact testing. Since specimens must be removed in three seconds or less and placed on a nearby test anvil, the close-to-the-floor design speeds testing. Cincinnati Sub-Zero Products, 3930 Reading Rd., Cincinnati 29, Ohio

FOR MORE DATA CIRCLE 44 ON PAGE 48

Vacuum Unit

Although designed primarily for coating materials with vaporized metals in laboratories, the LC1—14A Vacuum System can also be used for degassing liquids, crystal pulling and growing, melting small metal samples, and degassing vacuum-tube electrodes. Pump-down time, with a clean dry system, is six minutes to 0.5 micron Hg, with an ultimate pressure of 2 x 10^{-5}mm Hg. The work chamber, a 14" x 24" Pyrex bell jar, seats on a baseplate which has holes for vacuum-gauge sensing tubes, filament heating electrodes, and accessories. Rochester Division, Consolidated Electrodynamics Corp., 1775 Mt. Read Boulevard, Rochester 3, N. Y.

FOR MORE DATA CIRCLE 45 ON PAGE 48

(cont. from p. 23)

Editor Training. It is difficult to convince supervisors that they should assume complete editorial responsibility for the reports their men write. Convincing them that they should be teachers is even more difficult. Many supervisors feel the added burden would make their work load too great. Where this objection is valid, an adjustment in their work load is necessary.

Supervisors may not feel qualified to sit in judgment on matters of writing. These men should be given a chance to study editorial policies and procedures and to review the fundamentals of composition. Get outside help for this training. Several colleges offer special courses in technical editing; the Department of Humanities at M.I.T. will sponsor one in Cambridge this summer. And two professional societies, The Association of Technical Writers and Editors and The Society of Technical Editors, (which have just merged) are organized to give guidance and assistance.

Technical Writing Courses. The most obvious and practical means of instruction is a company course in technical writing. Here are some imperatives for such a course:

1. Give it your complete and enthusiastic support.
2. Make it thorough. (About 20 class hours.)
3. Tailor the syllabus to your group.
4. Choose a senior professional editor for instructor. a college professor of technical writing, or an experienced consultant.
5. Schedule meetings on company time.
6. Keep the classes small; 25 to 30 members is reasonable. (But the smaller, the better.)
7. Make enrollment voluntary, but once enrolled, make attendance compulsory.
8. Don't squeeze the course into a week or stretch it over a year. A two-hour meeting once a week is a good compromise—it is not too frequent to be a burden, nor so infrequent that discontinuity results.
9. Don't let the meetings be solid lecture. In a two-hour session, the first hour can be lecture; the second, discussion and practice, with coffee break between.
10. Whenever possible, choose written assignments from the regular writing load.
11. Select instruction material from a variety of sources and keep it to a minimum.

I suggest a course incorporating these features for both engineers and supervisors. If your supervisors want special instruction in editing, arrange for an hour-long editorial workshop in the afternoon before the class meets. This will permit the instructor to give individual attention to their problems, and they in turn can better supplement the instructor's efforts on the job.

Provide the References. If engineers hate anything more than writing reports, it's reading about how to write them. Keep references to texts at a minimum. Rely on samplings from livelier fields to develop good writing.

Report Manual. This is an indispensible aid to the engineer-writer. Include in it a review of the company's reporting system, descriptions and dummies of each kind of report, and general directions for preparing them. It should be required reading; well written, up to date, clear, brief, and attractive.

The purpose of the manual is to standardize the reports—their organization, presentation, and terminology—so that precious engineering time and tempers will not be lost in arbitrary decisions or arguments about petty matters of format. The standards should be adapted to reader needs and, in general, agree with accepted practice in the field.

I have often been asked if standards books do not hamper originality of expression. I suppose some manuals do. But the good manual does not dictate the length of a sentence nor the choice between words of equal weight and equivalent meaning. It is a framework, not a mold.

You might include in your manual an appendix of grammatical faults that can cause serious damage to meaning—vague pronouns, misplaced modifiers etc.

Commercial Textbooks. Every engineering group should have a text on technical writing. I recommend *Technical Reporting* by Joseph N. Ulman, Jr. (Henry Holt). The engineering and technical writing societies also have good publications on manuscript preparation and composition. You may wish especially to examine the American Standards Association's *Abbreviations for Scientific and Engineering Terms* (New York, 1941). These should be included in a readily accessible reference shelf. I will be happy to send a short bibliography on request.

I believe that successful instruction in report writing requires the best combination of instruction techniques and reference aids available. But, instruction by itself is not enough; it must be combined with practice. There are five reasons why a company improvement program is the logical means for insuring effective company reports.

First, it attacks the problems on all fronts, relating the parts to the whole; the practice with the doing.

Second, it takes the long-range view that improvement in writing cannot be expected overnight.

Third, it represents a combined effort.

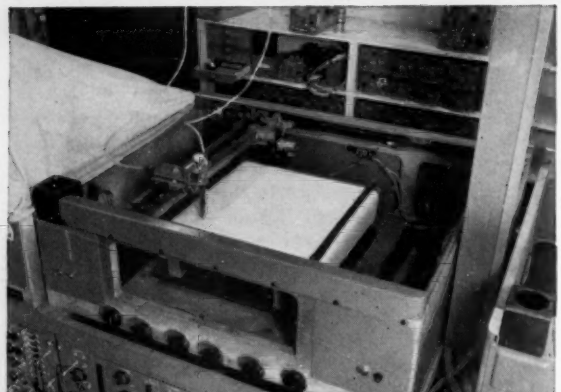
Fourth, it puts official approval on the instruction.

Fifth, it draws attention to the importance that industry attaches to competent technical writing.

The instruction costs for a complete course such as I have outlined is about $2500. Divide that by the number enrolled and the figure comes to a very reasonable $100 per man. Divide that $100 by the number of years the man will spend with your company and the figure becomes a pittance. And when you consider the incalculable results: the improved quality and readability of the reports and proposals, the enhanced sense of competence of your engineers; the improved employee relations; then the cost is less than negligible.

END

Robert R. Rathbone has been Assistant Professor of English for technical writing at M.I.T. since 1954. He was a writer and editor at Lincoln Laboratory, at M.I.T. for five years before that. Author of a series of articles on digital computers and pulse circuitry, he is consultant for a technical marketing firm, and a senior member of the Society of Technical Writers.



MIT Function Generator

plots curves on a special Bristol strip chart

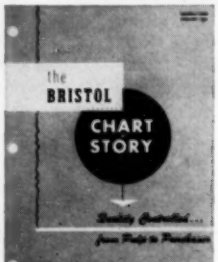
The strip chart above was designed and printed by Bristol especially for the MIT function generator.

It's one of hundreds of special strip and circular charts Bristol turns out each year to instrument builder specifications.

Why Bristol? Several reasons: We've been printing precision instrument charts for over 65 years, for one thing. We're familiar with instrumentation problems, for another. And, already one of the largest chart printers in the country, we've recently expanded our production facilities and engineering service.

What does this mean to you? It means that at Bristol you can get circular charts up to 12 inches in diameter—strip charts up to 29⅝ inches across. You can get charts for all kinds of special instruments—research, industrial, test, analytical, scientific, laboratory and pilot plant instruments and computors, to name a few. You can get charts printed on wax-coated, heat-sensitive, chemically-coated, electrically-sensitive or other special papers.

What's more, it will pay you to call on Bristol's chart service when your recorder is in the design stage. Put our long experience in designing both instruments and charts to work for you. Write the Bristol Company, 169 Bristol Road, Waterbury 20, Conn.



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AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

FOR MORE INFORMATION CIRCLE 19 ON PAGE 48

R/D Contracts

Rare Earths Research

A contract for fundamental research in the field of the rare earths has been awarded by the Air Research & Development Command to Horizons, Inc., Cleveland, Ohio. A point of primary interest is the potential applications of the rare earths in glass for optical equipment. Horizons will correlate data of the optical properties of glasses containing each of the rare earths in addition to such factors as hardness, density and other physical properties. The data will later be studied for ideas to assist in the structural details of optical glasses.

Horizons has also received a contract from the Naval Training Device Center, ONR, for the development of a photosensitive thermoplastic resin. The material will be used in the making of three-dimensional terrain models. Photosensitivity is required since a negative containing contour lines and names of rivers, towns, and other terrain features will be transplanted to the resin by photography. Most important is to find such a material which also will be thermally stable up to 300°F.

Radio Telescope

A dish-shaped radio telescope antenna 180 feet in diameter will be constructed at Green Bank, West Va. under a contract let by the National Science Foundation. The Associated Universities, Inc., will provide the basic research plus construction and operation of the radio telescope observatory. Some scientists believe that the new science of radio observation may eventually allow navigation of ships, airplanes and even guided missiles by the aid of invisible stars and intersteller gases.

Reactors for Italy and Belgium

Vitro Engineering Division of New York City has received a contract for engineering services on a CP-5 nuclear reactor research facility to be built in Milan, Italy. The reactor will be a heavy water type plant using enriched uranium as fuel. It is similar to a reactor operated by the Argonne National Laboratory at Lemont, Ill. Nuclear Development Corp. of America has been selected by the Belgian A.E.C. to design and develop Belgian Reactor-II, an engineering test reactor of advanced concept.

Data Reduction System

The Pratt & Whitney Div., United Aircraft Corp., East Hartford, Conn., has awarded a contract to Fischer & Porter Co., Hatboro, Pa., for an automatic data reduction system for use in its engine test cells at the Willgoos Gas Turbine Laboratory. The system will be capable of digitally recording pressure, temperature, flow, speed and miscellaneous parameters from a number of test cells simultaneously. The record will be automatically typed on a digital log sheet and also punched on IBM tabulating cards. Raw data will thus be immediately available for insertion into a digital computer for test analysis.

BOOKS

Modern Physics—A Textbook for Engineers

By Robert L. Sproull

Reviewed by R. C. Vickery, Contributing Editor.

Although the science of physics has its fundamentals firmly based, and although one can visualize little change in these fundamentals through the years, their applications are ever increasing. This book aims at the exposition of the application of basic physics to problems of engineering interest, particularly in regard to more recent developments.

Science is never static, and it is suitable that a book of this nature should be available. Developed from notes used in a one-semester course in Engineering Physics at Cornell, Professor Sproull's book has a very adequately developed section on the properties of elementary particles and their interaction. From the laws governing such interaction an exegesis of quantum physics is developed and applied to those problems of engineering interest which may be classed as "Solid State Physics". Physics of nuclear reactions is considered last, but the makeup of this volume is such that any teacher using the book as the basis of a modern physics curriculum may well reshuffle the subjects covered without undue loss of continuity of thought.

As is usual with textbooks of this nature, each chapter is followed by a list of references for further reading and a set of problems based upon data thus far considered—no answers are, however, listed for these problems, and this should be given attention in future editions.

The chapter on Binding and Energy Bands in Solids is adequate—but only just. A well developed presentation on variations of energetics through the different crystal forms and lattices would have greatly enhanced the value of this chapter.

Illustrations and line drawings are excellent; a few typographical errors detract nothing from the value of the book which, except in the instance referred to, adequately accomplishes the stated aims of the author to "present the basic physics, developed during the past few decades, underlying a large and growing part of industry". *John Wylie & Sons, Inc., New York, N.Y., 491 pages. $7.75.*

Creative Communication

By Edwin Cady

The fundamental bases from which a teacher must operate are, respect for his audience, respect for his material, and respect for language—the medium by which the two are brought together.

The author of this little book talks down to his audience; oversimplifies, and thereby distorts, his material; and disregards the dignity, the meaning, and the usage of language.

The book is ostensibly concerned with teaching precepts of good writing. It serves this purpose by inventing barbarisms, and then embracing them in quotation marks. It does it by using typographical tricks that are designed to clarify and emphasize but that only confuse, or dramatize the obvious.

The author writes "we-all" and "you-all" instead of all of us and all of you. He writes "communication-sensitive", whatever that means. He is given to laboriously breaking-down into A's, B's, C's, and D's, what needs only a conjunction or a comma.

Underlying all clear writing is clear thinking: the first is a consequence of the second. But the author's thinking has him attribute high selling costs, unfair and impractical government regulation, costly strikes, taxes, " and other ills", to poor communication (p.19). If poor communication is the real cause of society's internal differences, then all the governments and institutions of all men through all history have been fanciful solutions to fanciful problems.

So spirited a diatribe as this review is perhaps not invoked by this little book alone, but as much as by the company it keeps. The need for people to write clearly is very great; no less in industry than in any other part of our society—government, business, the military. Teachers who pretend to supply that need, who seek to impart knowledge of good usage without themselves employing good usage, are like patent medicine cures that don't cure. Their evil consists not in positive harm (they may be innocuous), but in soothing misgivings and excusing neglect—in this case, by substituting one kind of bad usage for another. In the end the problem is left unaffected—and so left to grow worse. This book does not teach.—SANDEK

Reinhold Publishing Corp., New York, N.Y. 158 pages, $2.50.

Chemical Market Research in Practice

By Richard E. Chaddock

Reviewed by John Rivoire, Manager of Market Research, Westvaco Mineral Products Div., Food Machinery & Chemical Corp.

Based on notes for a course of lectures given at Case Institute and at the University of Delaware, this book represents the combined work of 22 experts in the field. The foundation for the book was laid in 1953 when several members of the Chemical Market Research Association volunteered to deliver lectures on Chemical Market Research at Case. Subsequent revision and editing has produced this compact book. Its sixteen chapters deal with general background material of the chemical industry, market research techniques and problems, and specific areas such as the plastics industry, synthetic fibers, and sulfur.

The book is well organized, and despite its brevity, is not superficial; and it contains several valuable analyses of the chemical industry, market research techniques, and specific market research problems.

Research executives, whether or not they are directly concerned with market research or with the chemical industry, should find this book of considerable value. Those who have some immediate interest in market research will find it virtually indispensable.

Reinhold Publishing Corp., New York, N.Y. 196 pages. $3.00.

management affairs

Six of the most popular articles for improving technical management published in RESEARCH & ENGINEERING in recent months have been reprinted, including four by Luis J. A. Villalon, our Management Affairs Editor. Available for 25¢ each, they are listed below.

LIMIT THEOREMS: Practical Tool for Project Evaluation

THE DIFFICULT PERSONALITY PROBLEM IN R & D

EXECUTIVE HEALTH: 14 Ways to Maintain It

HOW'S YOUR STAFF EFFICIENCY?

HOW'S YOUR ORGANIZATION QUOTIENT?

TIME MANAGEMENT FOR THE RESEARCH EXECUTIVE

Reprints of the above articles on management problems are available for twenty-five cents each. Send check or money order to RESEARCH & ENGINEERING, *77 South St., Stamford, Conn.*

Reference Texts

Dictionary of Photography, Edited by A. L. M. Sowerby, Philosophical Library, 15 E. 40 St., New York, N.Y., 719 Pp., $10.

This is the eighteenth edition of the classic British work that first appeared in 1889. Its success is atributable to its relative comprehensiveness and clarity. Though not designed for the industrial user of photography, he will still find of value the basic understanding of the science the book affords. Photo-optics, -chemistry, and -physics, are treated at appreciable length. Though the entries are alphabetically arranged, an index would have been a desirable addition: and several articles that give relative exposures are less useful to the American reader because film indices are given in British units rather than in A.S.A. or Weston. But these are small objections to a substantial and otherwise useful book.

Pictorial Microwave Dictionary, Young and Jones, John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N.Y., 116 Pp. paper, $2.95.

A need for a ready reference book has developed with the increasing application of microwaves. This book attempts to supply part of that need. Definitions are clear—and, in the case of the extremely difficult subject of waveguides, at least candid. Concision is not always desirable or possible if a definition is to be meaningful and helpful; and so to insure maximum utility in cases that warrant them, the authors have supplied one or two explanatory paragraphs in addition to a concise definition. This is a convenient book, not a definitive one: the authors have directed it to technical people with little knowledge of advanced mathematics.

Encyclopedia of the Iron & Steel Industry, by A. K. Osborne, Philosophical Library, 15 E. 40 St., New York, N.Y., 558 Pp., $25.

This book seems admirably to fill its stated purpose: ". . . a work of reference, not a textbook; the specialist might usefully look to it for information on subjects bordering his own . . . a corrosion expert [for example] will find in it the full meaning of terms used in pyrometry . . . etc." We might add that the non-specialist will find it a valuable source of background for metallurgy in general. The book is well planned and illustrated. It has a few minor shortcomings, such as: the entry under *Strain* ends with a note to see also *Longitudinal Tensile Strain*, but the latter is not to be found. But quite aside from such minor, and probably not prevailing, annoyances, the book seems a helpful and valuable one.—LS

Advertising Index

ACOUSTICA ASSOCIATES, INC. 5
Agency—Robert E. Rolnik Associates

AUTOCLAVE ENGINEERS Cover III
Agency—Davies & McKinney

THE BRISTOL CO. 44
Agency—James Thomas Chirurg Co.

THE CARBORUNDUM CO., REFRACTORIES DIV. 19
Agency—G. M. Basford Co.

FISHER SCIENTIFIC CO. ... 33
Agency—Smith, Taylor & Jenkins, Inc.

FLUOR CORP. 7
Agency—Hixson & Jorgensen, Inc.

FOOTE MINERAL COMPANY 16
Agency—The Harry P. Bridge Co.

GENERAL CHEMICAL DIV., ALLIED CHEMICAL & DYE CORP. 2
Agency—Atherton & Currier, Inc.

GRAPHIC SYSTEMS 40
Agency—Diener & Dorskind, Inc.

INDIANA STEEL PRODUCTS CO. 10
Agency — The Fensholt Advertising Agency, Inc.

LABORATORY EQUIPMENT CORP. 41
Agency—Jones & Taylor Associates

LINDSAY CHEMICAL CO. .. 28
Agency — C. Franklin Brown, Inc.

LITHIUM CORPORATION OF AMERICA, INC. 8
Agency — Keystone Advertising, Inc.

NORTHROP AIRCRAFT, INC. 47
Agency — West-Marquis, Inc.

RADIO CORPORATION OF AMERICA 32
Agency—Al Paul Lefton Co., Inc.

RADIO CORPORATION OF AMERICA, TUBE DIVISION .....Cover II
Agency—Al Paul Lefton Co., Inc.

RAMO-WOOLDRIDGE CORP. .....Cover IV
Agency — The McCarty Company

RELYEA PUBLISHING CORP. 24, 25
Agency—Direct

TEKTRONIX, INC. 6
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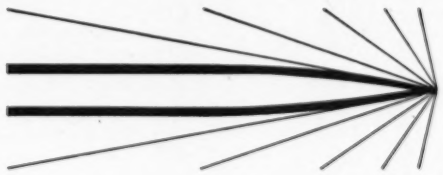

MISSILE ENGINEERS

Many new positions are being created at Northrop Aircraft for missile engineers in a wide range of activity: control, guidance, servo, computers, recording, optical, reliability, electro-mechanical, telemetering and electronics. There's an interesting position for you, at your own experience level, with attractive remuneration and steady advancement, in one of the following groups:

GUIDANCE AND CONTROLS, encompassing research and development of advance automatic guidance and flight control systems for both missiles and piloted aircraft. Specific areas of development include: radio and radar systems, flight control systems, inertial guidance systems, instrument servo systems, digital computer and magnetic tape recording systems, airborne analogue computer systems, optical and mechanical systems, and systems test and analyzer equipment.

FLIGHT TEST ENGINEERING SECTION, which plans the missile test programs and establishes test data requirements in support of the programs. The data requirements are predicated on the test information required by the engineering analytical and design groups to develop and demonstrate the final missile design, and are the basis from which instrumentation requirements are formulated.

The analysis work performed consists of aerodynamic, missile systems, dynamics, flight control, propulsion and guidance evaluation. The Flight Test Engineering Section is also responsible for the field test program of the ground support equipment required for the missile.

FLIGHT TEST INSTRUMENTATION SECTION, which includes a Systems Engineering Group responsible for the system design concept; a Development Laboratory where electronic and electro-mechanical systems and components are developed; an Instrumentation Design Group for the detail design of test instrumentation components and systems; a Mechanic Laboratory where the instrumentation hardware is fabricated; and a Calibration and Test Group where the various instrumentation items and systems are calibrated and tested.

For 17 years Northrop Aircraft has pioneered in missile research and development. As a member of this forefront organization in this growing field, new opportunities for full expression of your initiative and ability will always be yours at Northrop.

If you qualify for any of these attractive positions, we invite you to contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., telephone ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600-A1, Hawthorne, California.

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Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles

HERE'S A BRIEF REVIEW OF LAST MONTH'S PRODUCT ADS IN R/E FOR YOUR INFORMATION.

Hermetically Sealed Relay 55

The KM series of 3PDT relays comes in three types: open, hermetically sealed and latching. Applications range from remote control systems to small business machines. The open type occupies less than one cubic inch.

Potter & Brumfield, Inc., Princeton, Indiana.

Chemical Lab Supplies 56

This varied line of products includes our 30 rare earths, radioisotopes, and 1000 high-purity inorganic reagents, also organic chemicals and biological stains and indicators.

Baker & Adamson, General Chemical Division,
Allied Chemical & Dye Corporation,
40 Rector Street, New York 6, N. Y.

Oscillographic Recording 57

These single to 8-channel inkless oscillographic recording systems are made particularly flexible by means of a dozen interchangeable plug-in preamplifiers.

Sanborn Company, Industrial Div.
Cambridge 39, Mass.

Precision Forging 58

Precision-forged, contour-rolled parts result in great savings over parts made by conventional rough forging. The process can be applied to steel, titanium and other heat-resistant alloys.

A. O. Smith Corp., Milwaukee, Wisc.

Research Reactors 59

Any of these three basic research reactors—heavy-water, swimming-pool and nuclear test—can be modified to meet particular needs. A seven-point design and servicing plan comes with them.

Atomic Power Equipment Dep't,
General Electric Co., San Jose, Cal.

Scope with Plug-in Parts 60

By means of extra plug-in preamps, this oscilloscope can perform a greater variety of tasks. It also has two sweep generators.

Tektronix, Inc., P. O. Box 831, Portland 7, Ore.

Contract R/D 61

This chemical research and development offers a variety of specialists to supplement the efforts of your own R/D staff.

Evans Research & Development Corp.,
Dept. R1, 250 E. 43 St., N. Y. 17, NY

Polyurethane Foams 62

The basic chemicals and plasticizers for producing these extremely useful foams are available in quantity from this producer.

Celanese Corp. of Amer., Chemical Div.,
Dept. 548-L — 180 Madison Ave., New York 16, N.Y.

Gearhead Motors 63

These permanent magnet gearhead motors can be used as small switch actuators, programming devices and for remote positioning in automatic controls.

Barber-Colman Company, Dept. L,
1474 Rock St., Rockford, Ill.

Abrasion-Resistant 64

These silicon carbide refractories have unusual abrasion resistance at high temperatures. Also offer high heat conductivity compared to fireclay.

The Carborundum Co., Dept. 5126,
Refractories Div., Perth Amboy, N.J.

Ceramic Magnets 65

These permanent ceramic magnets offer high coercive force, low specific gravity, high potential energy and many other advantages where magnetic force is needed.

The Indiana Steel Products Co.,
Dept Q-12, Valparaiso, Indiana.

High Vacuum Pumps 66

Six models of compound high vacuum pumps offer free air displacements ranging from 2.0 CFM to 46.0 CFM. All are dynamically balanced.

Kinney Mfg. Div., The New York Air Brake Co.,
3642 Washington St., Boston 30, Mass.

Polymerization Catalysts 67

Lithium in metallic, hydride, hydroxide and carbonate forms offer possibilities as polymerization catalysts in both addition or condensation processes.

Lithium Corp. of America, Inc.,
2697 Rand Tower, Minneapolis, Minn.

System Components 6

These high-precision system components include synchros, servos, tachometer generators and gyros.

Kearfott Co., Inc., Little Falls, N.J.

Analyzes Jet Engines 6

Developers and designers of jet engines will find this instrument invaluable in analyzing engine performance.

B & H Instrument Co., Inc., 3479 W.
Vickery Blvd., Ft. Worth 7, Texas

Special Coatings 7

This organization thrives on unusual problems in vacuum-deposited coatings.

Liberty Mirror Div., Libbey-Owens-
Ford Glass Co., Brackenridge, Pa.

Tube Furnaces 7

Temperatures to 2600°F can be reached in 48 steps in these accurately controlled tube furnaces.

Hevi-Duty Electric Co., Milwaukee 1, Wisc.

Finds Vapor Pressures 7

This device increases the accuracy of low temperature fractional analyses of petroleum gases.

Central Scientific Co., 1734 Irving
Park Road, Chicago 13, Illinois.

Lab Press 7

Various accessories can be attached to this laboratory press, which features pressures to 20,000 lbs.

Fred S. Carver, Inc., 1 Chatham Rd., Summit, N. J.

Shaker 7

This basic shaker can be employed in six different vibration test systems.

The Calidyne Co., 120 Cross St., Winchester, Mass.

Versatile Fastener 7

Rollpins can replace locating dowels, hinge pins, rivets, set screws or various pins such as cotter pins.

Elastic Stop Nut Corp. of Amer.,
Dept. R38-1281, 2330 Vauxhall Road, Union, N.J.

Solvents 7

Through standard packaging by volume in gallons of these lab solvents, you save time and money and ease storing.

Fisher Scientific, 115 Fisher Bldg., Pittsburgh 19, Pa.

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4	14	24	34	44	54	64	74
5	15	25	35	45	55	65	75
6	16	26	36	46	56	66	76
7	17	27	37	47	57	67	77
8	18	28	38	48	58	68	78
9	19	29	39	49	59	69	79